BELLCOMM, INC.

955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D.C. 20024

B70 09031

SUBJECT: Skylab Communications Coverage and Data Handling for the "Pick-a-Day" Study - Case 620

DATE: September 4, 1970

FROM: J. E. Johnson

ABSTRACT

A day in the first Skylab mission is examined in detail from the viewpoints of Manned Space Flight Network (MSFN) coverage and real-time and tape-recorded data handling. A minute-by-minute timeline of crew activity, tape recorder and transmitter usage, MSFN coverage, and ground network circuit usage is developed for this day.

The MSFN in its present configuration (plus a new station planned for Santiago, Chile) can adequately support the Skylab activity assumed for the chosen day. Given reliable network operation, no problems should exist. There will be 63 total contacts on this day, with at least two on every revolution. Better than 25% of the day will be covered in real-time, and 100% of the day will be covered on a record-basis for the Airlock Module (AM) and the Apollo Telescope Mount (ATM). About 3.6 X 10^9 bits of data will be transmitted by the orbital assembly; about one-third of this data will be received simultaneously by more than one station. No gaps between station contacts will exist on this day in excess of any on-board tape recorder capacity, although gaps will occasionally occur on other days exceeding the ATM recorder capacity. The MSFN will be capable of simultaneously supporting lunar projects such as ALSEPs and a subsatellite around-the-clock with either one or two stations without compromising Skylab support in any meaningful way.

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MEMORANDUM FOR FILE

This memorandum presents a detailed timeline of Skylab communications coverage and data recording and transmitting activities for Day 10 of the initial mission (Skylab 1/2). It is one of a series of memorandums analyzing this day (termed "pick-a-day") in many different respects. The flight plan for this day has been somewhat arbitrarily designed to include a variety of Skylab experiments within a typical schedule of crew activity. Ground network coverage of the orbiting vehicle follows a very highly repetitive pattern from day to day, so the amount of coverage provided on this day may be considered to be typical. However, there will be other days when significantly longer gaps between contacts will occur (Refs. 3 and 4).

DESCRIPTION OF MODEL

The day chosen for this study is July 29, 1972, midnight-to-midnight EST, extending from an elapsed time of 9 days 9 hours to 10 days 9 hours, measured from an assumed Skylab 1 lift-off at 3 PM EST July 19. The orbital assembly is assumed to be in a 235 nm circular orbit with a 50° inclination. The crew activity timeline for this day was developed by Dr. D. J. Belz of Bellcomm.

Manned Space Flight Network (MSFN) visibility data was obtained from Ref. 1. A 12-station network was used - the presently existing MSFN plus a new station at Santiago, Chile. (See Table 1 for a list of these stations.) It was assumed the MSFN would simultaneously be required to support Apollo Lunar Surface Experiment Packages (ALSEPs) and perhaps a lunar subsatellite, and that this support would require use of an MSFN station with an 85-foot antenna around-the-clock. Lunar visibility data was also obtained for this day, and the 3 MSFN 85' antennas were scheduled to provide the necessary lunar support. This resulted in loss of 6 of the 73 potential Skylab contacts. Four other available contacts were of less than 3-minute duration (above 2° elevation), and were considered to be too short to be of significant value. MSFN support for this day is shown in Figure 1 and summarized in Table 1. MSFN station capabilities are given in Table 2 (from Ref. 2).

TIMELINE DEVELOPMENT

A minute-by-minute timeline was developed for this day and is presented in Appendix B. It shows crew activity, on-board data recording, playback, and real-time transmission for each module, MSFN coverage, and NASA Communications Network (NASCOM) circuit utilization for transmission of data to flight controllers and experiment principal investigators in real-time or near-real-time.

Methods of experiment operation, status monitoring, network operation, etc., in general are not precisely defined at this time. Numerous assumptions had to be made, sometimes rather arbitrarily. Except where there were indications to the contrary, Apollo-type MSFN operation was assumed. The most significant assumptions used to derive the following results are discussed in Appendix A.

SUMMARY OF RESULTS

The data derived in this study may be analyzed in many different ways, depending on a user's particular interest. Several different summaries will be given here; many more are possible.

On-board tape recorder usage for this day is as follows:

Recorder	Record Time (min)	Rewind and/or Playback Time (min)	Total (min)	% of Day
CSM	120.0	7.5	127.5	8
ATM #1	1102.0	185.0	1287.0	89
ATM #2	0	0	0	0
AM #1	1068.6	50.9	1129.5	78
AM #2	174.0	7.9	181.9	13
AM #3	17.0	.8	17.8	1

It was assumed that Apollo Telescope Mount (ATM) recorder #1 and Airlock Module (AM) recorder #1 would always be used for housekeeping/continuous data record purposes. It might be desired instead to share the load among the available recorders. The AM #3 recorder is required on this day only in support of M093 (Vectorcardiogram experiment). Experimental usage of the second and third AM recorders could be heavier on some other days with a different experiment mix; however, it appears that it would require about an order of magnitude increase in experiment recording requirements before a "work-around" situation was encountered. The maximum recording time of 4 hours for an AM recorder is never a constraint; on this day the maximum recording time of 90 minutes for an ATM recorder is not a constraint either. The longest gap between MSFN contacts of at least 6 minutes duration above 2^o elevation is 80 minutes (from a $10^d04^h34^m$ loss at MIL to a $10^d05^h54^m$ acquisition at GDS). On other days, gaps greater than 90 minutes can occur. Three occur on the 4 days preceding this one (Ref. 3), and 21 occur over 28 days. The longest gaps between 6 minute contacts last about 135 minutes (Ref. 3,4).

Skylab transmitter usage for this day is summarized below.

Transmitter	Minutes "On"	% of Day
CSM PM (low power)	319.4	22
CSM PM (high power)	101.0	7
CSM FM (high power)	17.8	1
ATM #1	1440.0	100
ATM #2	1440.0	100
AM #1	420.4	29
AM #2	102.3	7
AM #3	64.8	5

It is assumed the transmitters will be turned on by ground command when the elevation angle from the station to the vehicle ascends above 2^o, and turned off when the angle descends below 2^o (except for the ATM transmitters, which are left on continuously). The CSM Phase Modulation (PM) high-power mode is used for transmission of real-time 51.2 kbps data. The low-power mode is used for transmission of real-time 1.6 kbps data. The Frequency Modulation (FM) high-power mode is used only for transmission of recorded data and for TV. AM transmitter #1 is assumed to be used only for real-time 51.2 kbps data, whereas #2 is used primarily for dump of either housekeeping data or experiment data, and #3 is used primarily for dump of recorded voice. Real-time voice will be transmitted via the CSM PM transmitter in either high-power or low-power modes.

The heaviest simultaneous NASCOM circuit usage for real-time and post-pass telemetry data is seven 4.8 kbps circuits, occuring around $9^d20^h15^m$, and again briefly around $10^d04^h31^m$. All real-time and post-pass data funnels into a 50.0 kbps wide-band circuit (with a back-up) between GSFC and MSC. Straight multiplication yields a maximum rate of 33.6 kbps on this pipe. However, tracking and command data also flow over this route, and the reformatting necessary at GSFC to transform incoming and outgoing data rates, plus GSFC - MSC error checking, when added to the telemetry totals could overflow the capacity of this link. If compressed data is sent from the MSFN post-pass directly to MSC, it may also use this circuit (see page 7).

The MSFN support assumed for this day for both Skylab and lunar projects is shown in Fig. 1. Skylab contacts are indicated by dots, lunar visibility by straight lines. Lunar support around-the-clock by the 3 deep-space stations of Goldstone (GDS), Madrid (MAD), and Honeysuckle Creek (HSK) was assumed. Figure 2 increases lunar support by the addition of a second station around-the-clock. By careful choice of station selection, only two extra Skylab contacts were lost relative to Fig. 1. All the totals given below and in Appendix C are based on the support shown in Fig. 1.

MSFN coverage and the data load for each station is summarized in Table 1. Seventy-three contacts are potentially available. Of these, four were deleted as being too short (less than 3 minutes above 2^o elevation above the horizon) to be worth the trouble. Six more were deleted because of the assumed need to support ALSEPs and the lunar subsatellite, and because their deletion did not appear to compromise Skylab support in any significant way. Of the 63 remaining, 53 were long enough (more than 6 minutes above 2^o) to permit an ATM tape dump. The average contact duration was 8.0 minutes, the maximum 10.2 minutes.

There are at least two contacts on every revolution for this day. On some other days there is only one. The distribution of contacts per revolution is shown on the next page. The actual contacts exclude those lost due to lunar support.

Contacts per Revolution	Number of Occurrences: Possible > 3.0 min	Actual > 3.0 min	Actual > 6.0 min
0	0	0	0
1	0	0	1
2	2	2	3
3	2	2	1
4	3	4	5
5	0	2	2
6	3	1	1
7	3	3	1
8	1	0	0

To illustrate the consistency of MSFN coverage from day to day, the contacts of greater than 3 and 6 minutes for the four days preceding "pick-a-day" are shown below, along with the "pick-a-day" totals. The July 25 - 28 data is from Ref. 3.

Day	Potential Contacts > 3.0 min	Contacts lost due to Lunar Support	Contacts Supported	Contacts Supported > 6.0 min
July 25	67	7	60	49
July 26	70	7	63	52
July 27	67	6	61	54
July 28	65	5	60	51
July 29	69	6	63	53
Averages	67.6	6.2	61.4	51.8

It was assumed manning of an MSFN station would be required from one hour before the first contact for set-up and check-out purposes to one hour after the last contact for post-pass data transmission, logging, etc. A station with latitude between 30° N and 30° S will have gaps in its coverage pattern (see Fig. 1). The nearer the equator the station, the longer these gaps will be, and the fewer total contacts. This is a consequence of the station coverage circle radius (for 2° elevation, 235 nm altitude) being about 20° of great circle arc. For a station at a latitude less than 30°, the ground track of an orbit with a 50° inclination will sometimes pass north of the circle in the northern hemisphere, or south of it in the southern hemisphere. Higher latitude stations (chiefly the deep-space stations) are thus more efficient in providing coverage for high inclination orbits. The average manning time ("up" time) for Skylab support was 9.4 hours to support 5.3 contacts. A total of 504 minutes of coverage was provided. Subtracting overlapping coverage, 416 minutes of the day was covered, or 28.9%.

The data load for each station is tabulated in Appendix C. It was calculated assuming that recorded data would be dumped to the first station to acquire if it had a sufficiently long contact duration, and only to that station (unless an experiment was in operation where a recorder interruption was believed undesirable). One half minute was allowed after theoretical acquisition above 2°, and also before loss below 2°. The total bits collected were 4.7×10^9 for all stations. Only a small percentage of this data is returned in real or near-real time. The "unique" data collected was 3.6×10^9 bits. This total eliminates most of the overlap between adjacent stations having simultaneous visibility, and also assumes that overlapping ATM dump data can be eliminated (each dump of the ATM recorder contains 90 minutes of recorded data, most of which has usually been dumped to an earlier station).

Another parameter developed and shown in Table 1 is a station "efficiency". It is the ratio of "unique" data bits collected by a station to the total hours that station is "up" for Skylab support. This depends obviously, but not overwhelmingly, upon the times experiments with high recording rates are scheduled. Also, the assumption that recorded data would be dumped to the first station with contact duration long enough to accept all of it biases the efficient stations to the west of overlapping groups (CYI over MAD), (GDS over TEX, MIL, BDA; TEX over MIL and BDA; MIL over BDA). Using this criterion, HSK, GDS, and HAW are "efficient" stations; BDA, MIL, MAD, TEX, and GWM are not.

A new method for experimental data return is being planned for Skylab. This is termed Data Redundancy Removal (DRR). After an MSFN site has completed its active support for the day, it would use its on-site computers to compress all of the data received and recorded on all of the passes it supported. All redundant data samples would be deleted. The compressed data would be recorded on a master digital tape, and later transmitted via two 4.8 kbps data lines at a time selected so as not to overload the NASCOM network capacity. Using this technique, all data should be returned to the US within a few hours instead of the days or even weeks now required for physical shipment of the non-compressed data tapes. There is some question at this time as to whether the compressed data would be transmitted only as far as GSFC or whether it will be hard-lined directly to the ultimate users at MSC and/or MSFC. Details on the DRR technique as planned by the GSFC Network Computing Branch are given in Ref. 5, available from me.

In Ref. 5, GSFC has estimated a typical data load after DRR processing as 2.68×10^7 bits/station-day. This assumed a 95% redundancy factor. That is, 95% of all parameter sample values did not change between successive samples. With the possible exception of biomedical data, Apollo experience has shown this assumption to be conservative; Apollo data, even during high activity periods, has almost always been more redundant than this. Extrapolation of this result to Skylab may not be considered valid due to Skylab's high experimental activity. However, Skylab experimental data quantities are less than housekeeping/ systems monitoring data quantities, particularly for the experiments using the AM recorders. Also, a quick scanning of experiment measurement lists and sampling rates yield the impression that the experimental data (excepting biomed) will be largely highly redundant. The average DRR data load developed in this study with a 95% redundancy factor is 1.5×10^7 bits/station-day, or 56% of GSFC's estimate. Biomed data has been excluded, as ample capabilities will probably exist for near-real-time transmission of any reasonable quantity of biomed data over NASCOM facilities. The biomed data, operational and experimental, for this day amounted to 3.8×10^7 bits, which included some "fill".

CONCLUSIONS

The MSFN coverage capability for this day appears adequate to support Skylab simultaneously with lunar projects, assuming all MSFN stations are operational. An ample amount of coverage is available, and the gaps between successive contacts do not exceed the on-board recording capabilities. Other studies (Ref. 3,4) have shown that the total amount of coverage available on other days is quite closely comparable, but that longer gaps between contacts will occasionally occur. If limited use can be made of the second ATM tape recorder (average of less than once a day), no data should be lost during the mission.

In general, loss of one or even two stations for a moderate length of time (perhaps up to a day) would not severely affect Skylab support. There are at least two contacts per revolution on this day, and at least one per revolution every day. The stations most useful as gap-fillers, either of whose loss could introduce extended gaps between contacts, are Hawaii and Santiago.

MSFN operations will have to be carefully pre-planned, due to the limited contact duration and the necessity of commanding on-board recorders and transmitters (plus other activities such as teleprinter updates). Each of the three types of on-board recorders have different record and playback characteristics and operate at different speeds.

Data redundancy removal appears highly desirable to prevent accumulation of a large backlog of recorded data, and to permit its usage in near-real-time by flight controllers and experiment principal investigators. The quantities developed in this study should be useful in estimating the magnitude of the redundancy removal task, and its impact upon station scheduling and NASCOM circuit loading.

The timeline development of this study is to a large extent arbitrary. Although an effort was made to coordinate, it may not be completely consistent with assumptions or constraints of others working on the "pick-a-day" scenario. Suggestions, comments, criticisms, etc. are invited. If significant changes appear warranted, a revision will be issued. Also, if the development of other communications-related parameters is of interest, I would appreciate being told about them.

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Table 1

MSFN Station Support Summary

Station	Code	Skylab (SL) Contacts Supported	Minutes of Support	SL "Up"* Time (Hrs)	Lunar "Up" Time (Hrs)	Total "Up" Time (Hrs)	SL Bits Collected ($x10^6$)	Unique SL Bits Collected ($x10^6$)	Unique Bits/Hr "Up" ($x10^6$)
Merritt Island, Fla.	MIL	6	45.5	10.5		10.5	382	227	21.6
Bermuda	BDA	7	53.4	12		12	392	236	19.7
Canary Island	CYI	5	41.6	9		9	391	279	31.0
Madrid, Spain	MAD	7	33.9	12	11.5	23.5	465	291	24.2
Ascension Island	ACN	4	59.6	7.5		7.5	322	273	36.4
Carnarvon, Aust.	CRO	5	39.2	9		9	387	328	36.5
Honeysuckle Creek, Aust.	HSK	2	19.1	3.5	8	11.5	188	175	50.0
Guam	GWM	4	27.8	7.5		7.5	246	214	28.6
Hawaii	HAW	5	38.1	10		10	435	415	41.5
Goldstone, Calif.	GDS	6	50.6	10	10	20	567	499	49.9
Corpus Christi, Tex.	TEX	5	54.5	9		9	380	233	25.9
Santiago, Chile	SAN	7	40.7	12.5	___	12.5	533	437	35.0
Totals		63	504.0	112.5	29.5	142.0	4688		
Total subtracting overlap			416.4	(28.9% of day)				3607	
Station averages		5.3	8.0	9.4			391	301	32.0

* "Up" time is measured from one hour before the start of support to one hour after the termination of support. It does not include the time required for data redundancy removal processing (see text).

Table 2 (From Ref 2)

GROUND SUPPORT INSTRUMENTATION

Equipment	STATION													
	MIL[1]	BDA	CYI	ACN	MAD	CRO	GWM	HSK	HAW	GDS	TEX	SAN		VAN[2]
Tracking														
C-Band Radar	x	x				x								x
USB/CCS	x	x	x	x	x	x	x	x	x	x	x	x		x
Telemetry														
VHF	x	x	x	x	x	x	x	x	x	x	x	x		x
USB/CCS	x	x	x	x	x	x	x	x	x	x	x	x		x
Data Processor	x	x	x	x	x	x	x	x	x	x	x	x		x
Data Remoting	x	x	x	x	x	x	x	x	x	x	x	x		x
Biomed Remoting	x	x	x	x	x	x	x	x	x	x	x	x		x
Data Recording	x	x	x	x	x	x	x	x	x	x	x	x		x
Command														
UHF Updata	x	x	x	x	x	x	x	x	x	x	x	x		x
USB/CCS Updata	x	x	x	x	x	x	x	x	x	x	x	x		x
CMD Processor	x	x	x	x	x	x	x	x	x	x	x	x		x
CMD Remoting	x	x	x	x	x	x	x	x	x	x	x	x		x
A/G Voice														
VHF	x	x	x	x		x	x		x	x	x	x		x
USB	x	x	x	x	x	x	x	x	x	x	x	x		x
TV														
S-Band TV Record	x	x	x	x	x	x	x	x	x	x	x	x		x
R/T Transmission	x				x			x		x				
SPAN[3]	x		x			x								

1 - Includes equipment in Cape area not considered to be a part of MIL.

2 - VAN - Vanguard tracking ship, used for launch, insertion, rendezvous and docking phases only.

3 - SPAN - Solar Particle Alert Network.

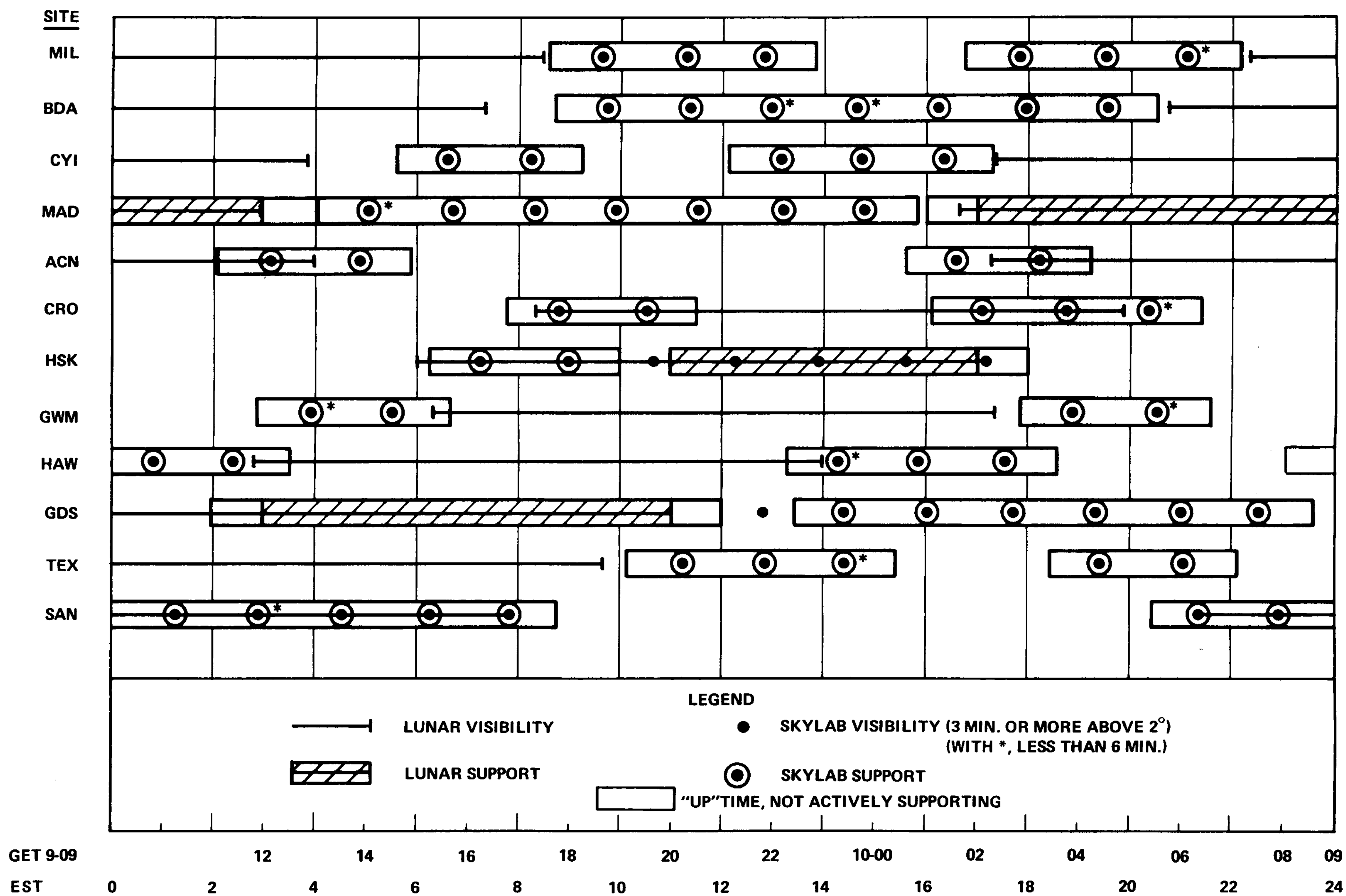

FIGURE 1 - LUNAR AND SKYLAB SUPPORT - "PICK-A-DAY" (7-29-72)
SINGLE STATION LUNAR SUPPORT

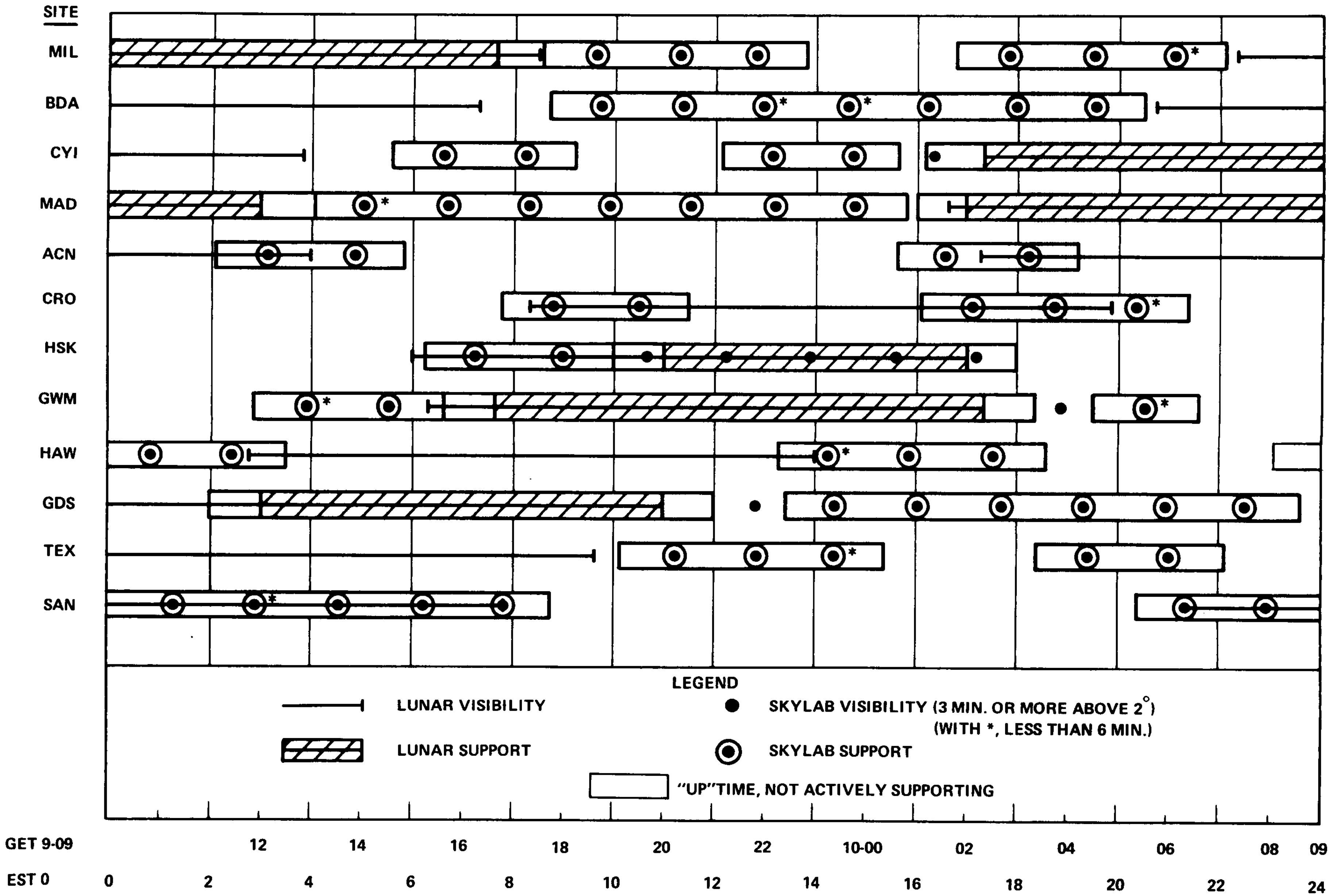

FIGURE 2 - LUNAR AND SKYLAB SUPPORT - "PICK-A-DAY" (7-29-72)
TWO STATION LUNAR SUPPORT

REFERENCES

1. "Reference Trajectory Data for the 'Pick-a-Day' Study", Bellcomm Memorandum for File, B70 05016, by I. Hirsch, May 11, 1970.

2. Skylab Program Support Requirements, NASA, Washington, D.C., July 20, 1970.

3. "Combined Skylab and Lunar Support with a Reduced Manned Space Flight Network", Bellcomm Memorandum for File, B70 05040, by J. E. Johnson, May 22, 1970.

4. "Effect of Manned Space Flight Network Reduction on Skylab Support", Bellcomm Memorandum for File, B70 05042, by J. P. Maloy, May 22, 1970.

5. Data Redundancy Removal at Remote Sites of the Manned Space Flight Network, GSFC Technical Report, September 1969.

6. AAP Flight Plan Impact as a Result of AM Data System Capabilities, Martin Marietta Corp. Report PR 35-334, November 7, 1969.

APPENDIX A

METHOD OF OPERATION ASSUMED FOR TIMELINE DEVELOPMENT

CSM OPERATION

The CSM will generally be in a powered-down status on this day. A general guideline during Skylab missions will be to avoid heavy use of the CSM transmitter power amplifiers, since all power must be drawn from the workshop and/or ATM. For this day the workshop power reserves appear more than ample; however, the guideline has still been followed. Normal CSM communications will use the USB Phase Modulation (PM) mode 4. This provides 1.6 kbps real-time CSM telemetry and crew voice, regardless of crew location. This mode will permit adequate signal strength margins without the use of a power amplifier. Power amplifier usage will be required for brief periods when high-bit-rate real-time or dump CSM telemetry (51.2 kbps), or television (ATM experiments) is wanted.* For this day, the power amplifier usage amounts to about 85 minutes, or about 7% of the time. This permits:

(1) two ATM TV transmissions,

(2) an approximately one-hour in-depth CSM status check with a crewman manning the module, and with high-bit-rate real-time transmission to MSFN stations,

(3) a dump of two hours of CSM 1.6 kbps recorded data, and

(4) three additional periods roughly equally spaced throughout the day of high-bit-rate data while the CSM is unmanned.

CSM communications modes will generally be controlled by the MSFN by use of Real-Time Command (RTCs), and will not require crew involvement.

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*There will be periods for high elevation passes when adequate margins can be obtained for high-bit-rate real-time data without use of the power amplifier. Dump data and television will always require use of a power amplifier. This study assumed use of a power amplifier throughout the entire contact whenever high-bit-rate data was transmitted.

ATM OPERATION

A continuous record of ATM operation is wanted. This requires recording whenever the assembly is out of contact with a ground station, and dumping simultaneously with real-time data transmission during station passes. The ATM recorder does not rewind; tape dumping is accomplished by using a fast forward (18:1) mode. Since the recording capability is 90 minutes, a minimum 5-minute station contact is required to dump. Mode commanding is assumed to be performed by the ground using RTC's. This will override an on-board pre-programmed mode of operation.* Allowing for acquisition time and commanding, a minimum 6-minute contact was used for an ATM tape dump.

At least once per day there will be an ATM TV transmission. This will require use of the CSM USB system. Two were scheduled for this day, both to the Goldstone MSFN station during the time allocated to ATM experiment operation.

AM-MDA-OWS OPERATION

A continuous record of workshop housekeeping data is wanted. This data is available on prime subframe #1 in the AM PCM telemetry system. It will be recorded on one of the 3 AM recorders whenever the assembly is out of contact with a ground station. It will be dumped without rewinding at a 22:1 ratio simultaneously with real-time PCM data transmission. The other two recorders are used for experiment data or operational biomedical data. Experiment data requirements were obtained from Ref. 6 and discussions with Bellcomm personnel.

Up to three voice and/or data streams can be transmitted simultaneously over the 3 AM transmitters. Normally, one transmitter will be used for real-time 51.2 kbps data, one for dumping the housekeeping data at 112.64 kbps that had been recorded at 5.12 kbps, and the third for dumping voice recorded concurrently with the housekeeping data. AM recorder and transmitter operation can be controlled by the ground via RTC's and normally will be except for start and stop control of experiment data recording.

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*The ATM recorder is presently programmed to play back for 6 minutes (allowing one minute of redundant read-out), and then automatically switch to the record mode.

One operational electrocardiogram (EKG) is assumed to be wanted from each crewman at least once a day.* A thirty minute period was arbitrarily selected for each crewman at a time when he was not active in an experiment, and EKG and other biomedical data was recorded on one of the experiment recorders for later dump. The Vectorcardiogram experiment M093 requires recording of three EKG vector components and requires use of both recorders, whereas only one component and one recorder is required for operational biomed monitoring. On this day the only time all three recorders are required simultaneously is during the running of M093.

MSFN COVERAGE

MSFN contacts of at least 3 minutes were considered useful, although a minimum 6-minute contact was used for ATM tape dumps. All times were measured from 2° elevation above a smooth Earth. No distinction was made between USB coverage for the CSM and VHF coverage for the ATM and AM. In practice, the USB contact duration would generally be shorter due to the need to establish 2-way phase lock, and the possibility of entering an antenna "keyhole". Three stations with 85' USB antennas were used to support ALSEPs and the lunar subsatellite (the shaded bars on Fig. 1). It was assumed they would not simultaneously be able to support Skylab. This eliminates 6 potential Skylab contacts. However, simultaneous USB coverage of ALSEP/subsatellite and VHF coverage of Skylab may be possible. This would most likely require recording of lunar data for later processing and using the remote site computers for real-time support of Skylab. Depending on the then-current subsatellite operating mode, it may be desirable at certain times to also use a 30' MSFN station for support. A possible MSFN support schedule for around-the-clock two station lunar support is shown in Fig. 2. This eliminates 2 additional contacts, which are not significant to Skylab. Dual mission coverage by the MSFN is discussed more fully in Ref. 3.

One-half minute was allowed after theortical acquisition above 2° elevation, and similarly before loss below 2° to allow for terrain masking, verification of good data, and commanding of tape recorders and transmitters.

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*An operational biomedical recording capability does not now presently exist except inside the CM. However, such a capability has been defined to be a "mandatory requirement", so it will probably be added. A real-time capability does currently exist.

MSFN OPERATION

It was assumed that Remote Site Data Processors (RSDPs) would continue to operate in real-time and near-real-time in much the same way as they do for Apollo. Downlink PCM bit streams will continue to be sampled by the RSDPs at (generally) a much lower rate than they were sampled on-board, and the data will be placed on one of the site's two 4.8 kbps high-speed telemetry data lines for transmission to MCC in real-time. (These data lines currently operate at 2.4 kbps, but upgrading to 4.8 kbps is firmly planned for the near future.) Thus a total of 9.6 kbps are assumed to be transmitted in real-time. A choice among different real-time data formats is commanded to the RSDPs pre-pass by MCC to emphasize whatever types of data are of most immediate current interest. In general, a mixture of the real-time data from the CSM, AM, and ATM could be expected to be selected. The dump data would be recorded at the station. Post-pass, it would be input to an RSDP where it would be sampled and returned in much the same manner as the real-time data. Only one data source at a time and only one high-speed data line were assumed for playback of dump data. (This may be an unnecessary constraint.) Five minutes were allowed between successive transmissions for set-up purposes.

Data redundancy removal processing was not timelined. Start and stop times for processing the data subjected to compression would be under control of an MSFN co-ordinator. Only the unique data (the 3.6×10^9 bits) would need to be subjected to compression. Transmission of the compressed data would be controlled by a NASCOM co-ordinator to prevent overloading of NASCOM circuits and interference with real-time data from other sites.

NASCOM OPERATION

Each MSFN station will have two 4.8 kbps circuits for telemetry data transmission. There may be an additional circuit for biomedical data. (Due to its low redundancy factor, biomedical data may not be subjected to data compression.) Other circuits will be used for tracking data, command, air-ground voice, and voice for station operations coordination. Circuit usage for these other functions is not considered here. It was assumed both 4.8 kbps circuits would be used for real-time telemetry transmission from one-half minute before station visibility to one-half minute after loss of visibility. Dump data from the CSM, ATM, and AM was assumed to be transmitted post-pass, one module at a time, on only one circuit, and with a 5-minute allowance for set-up. EKG's were also assumed to be sent post-pass at the same speed as they were recorded on-board, with only one vector component being sent at a time. (One component = 320 samples/sec.x8 bits/ sample = 2560 bits/sec.) The EKG's were thus excluded from the data compression to be performed later at the site.

APPENDIX B

"PICK-A-DAY" COMMUNICATIONS COVERAGE AND DATA HANDLING TIMELINE

A minute-by-minute timeline of crew activity, module data recording and transmitting, MSFN coverage, and NASCOM circuit utilization is shown in the following pages. Each page covers 50 minutes. Ground Elapsed Time (GET) and Eastern Standard Time (EST) are shown along the bottom as days-hours-minutes. The activity of each crewman is shown at the top, followed by CSM, ATM, AM, and special experiments data recording and transmission. The symbols used are the following:

R - Record

RT - Real-time transmission

D - Dump of previously recorded data (playback)

V - Voice, either real-time or recorded, as indicated

RNG - Ranging

3 letter MSFN codes - See Table 1

Numbers - Transmit or record rate in kbps

Experiment number - See Table B-1

ASAP - Auxiliary Storage and Playback (ATM recorder)

HK - Housekeeping data recorder in AM

DSE - Data Storage Equipment (CSM recorder)

CSM operating modes:

PM 1 - Phase modul., 51.2 kbps telemetry and voice

PM 2 - Phase modul., 51.2 kbps telemetry, voice and ranging

PM 4 - Phase modul., 1.6 kbps telemetry and voice

PM 5 - Phase modul., 1.6 kbps telemetry

PM 15 - Phase modul., 51.2 kbps telemetry and ranging

FM 4 - Freq. modul., television

FM 12 - Freq. modul., playback of 1.6 kbps telemetry at 32:1

Table B-1

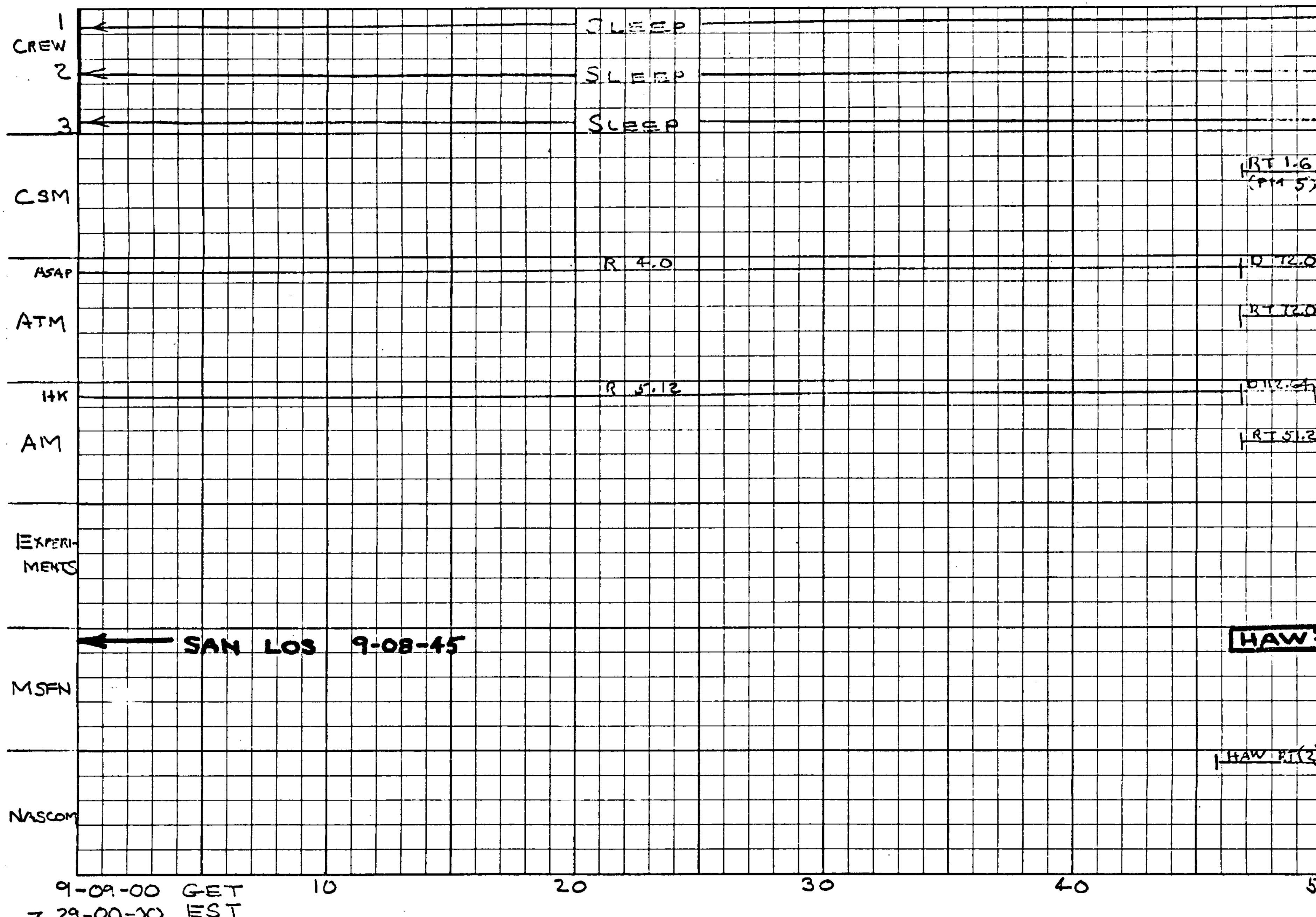
PROPOSED EXPERIMENT OPERATIONS

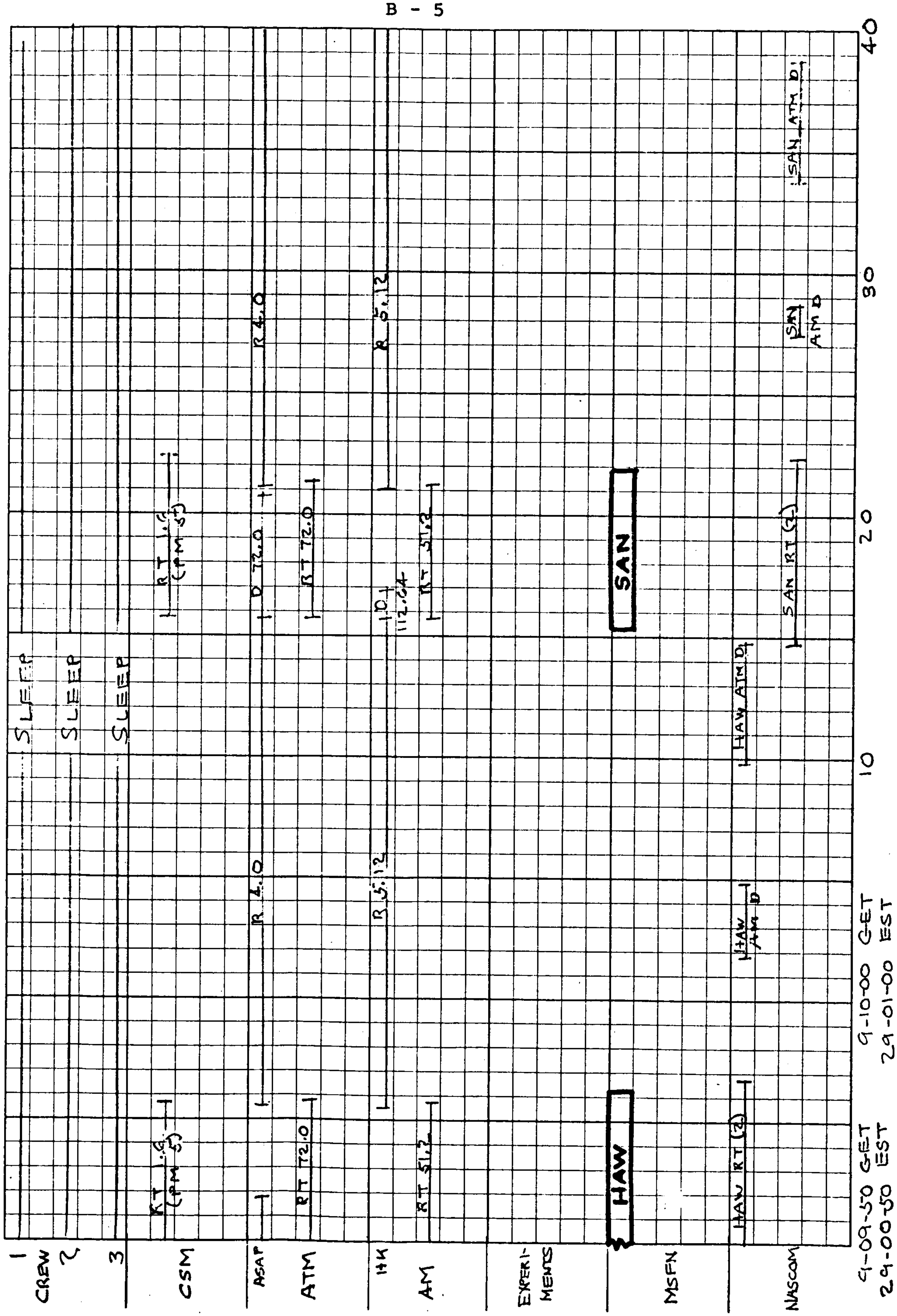
FOR THE "PICK A DAY" STUDY

D021	-	Expandable Airlock Technology* (Airlock Leak Test in progress; EVA portion of experiment not yet performed)
M071	-	Mineral Balance
M073	-	Bioassay of Body Fluids
M074	-	Specimen Mass Measurements Device (Excluding calibration operations)
M093	-	Vectorcardiogram
M131	-	Human Vestibular Function (Semicircular Canal Test Only)
M151	-	Time and Motion Study
M172	-	Body Mass Measurement (Excluding calibration operations)
M509	-	Astronaut Maneuvering Equipment (Run 4 only)
S015	-	zero-G Single Human Cells* (Feed and photo sequences only)
S019	-	UV Stellar Astronomy (Setup and observations)
S052	-	White Light Coronagraph
S054	-	X-Ray Spectrographic Telescope
S055	-	UV Scanning Polychromator/Spectroheliometer
S056	-	X-Ray Telescope
S082A	-	Coronal XUV Spectroheliograph
S082B	-	Chromospheric XUV Spectrograph
S190	-	Multispectral Photographic Facility
S191	-	Infrared Spectrometer
S192	-	10 Band Multispectral Scanner
S193	-	Microwave Scatterometer, Altimeter & Radiometer
T003	-	Inflight Aerosol Analysis (Measurements in crew quarters only)
T025	-	Coronagraph Contamination Measurement (Setup and observations)

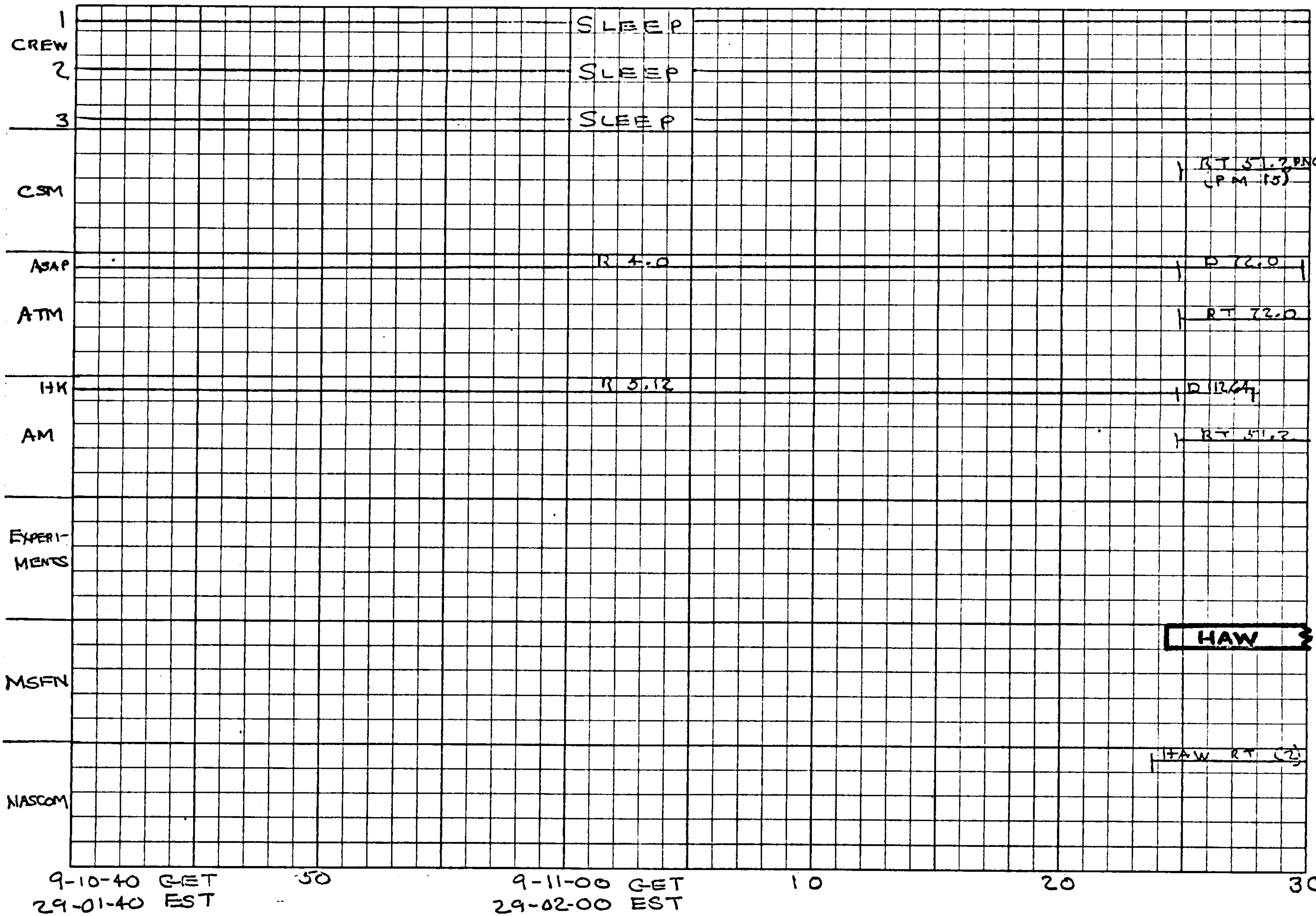
$\left.\begin{array}{l}\text{S190}\\\text{S191}\\\text{S192}\\\text{S193}\end{array}\right\}$ Earth Resources Experiment Package (EREP)

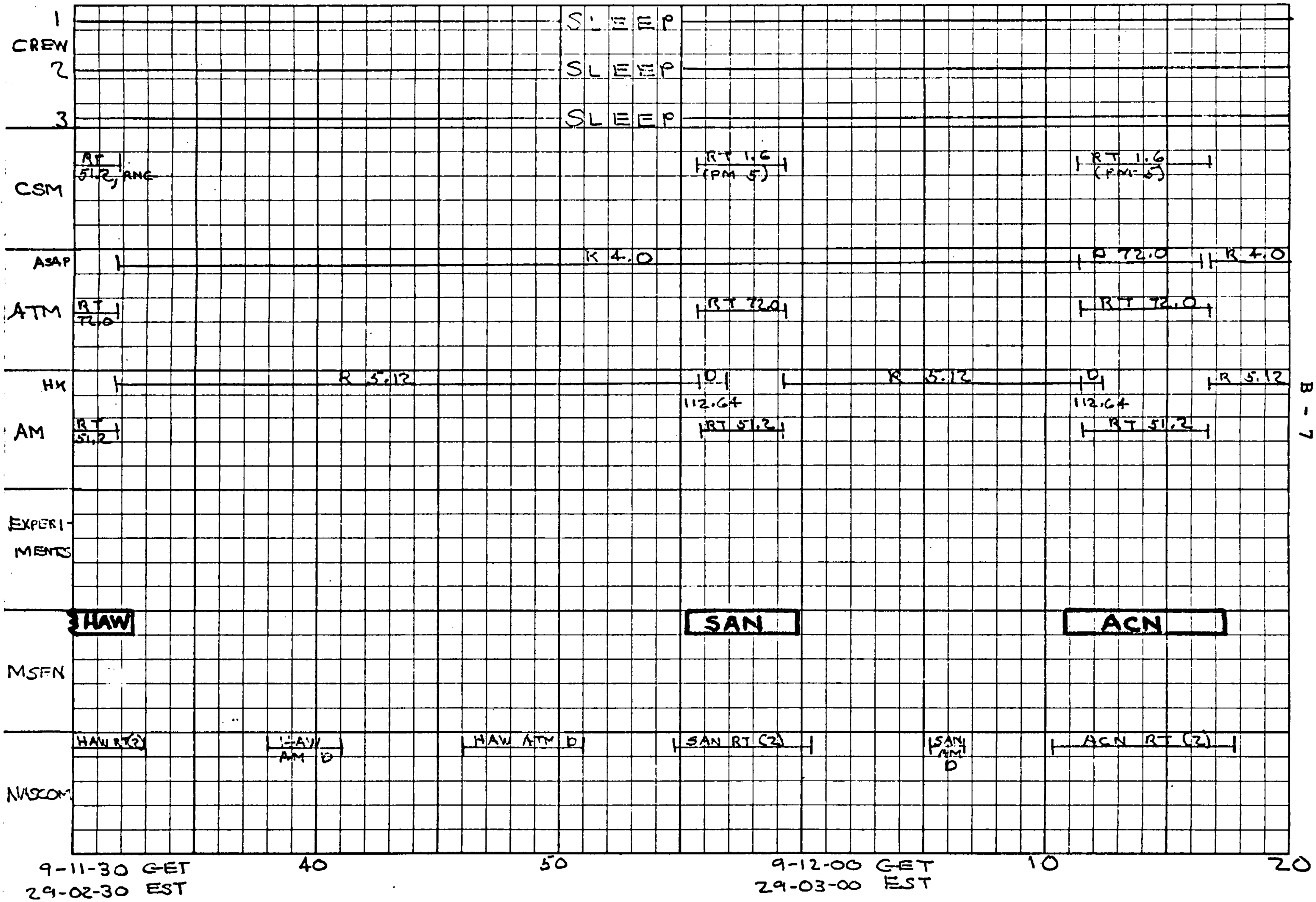
*No astronaut participation during the mission day under study.

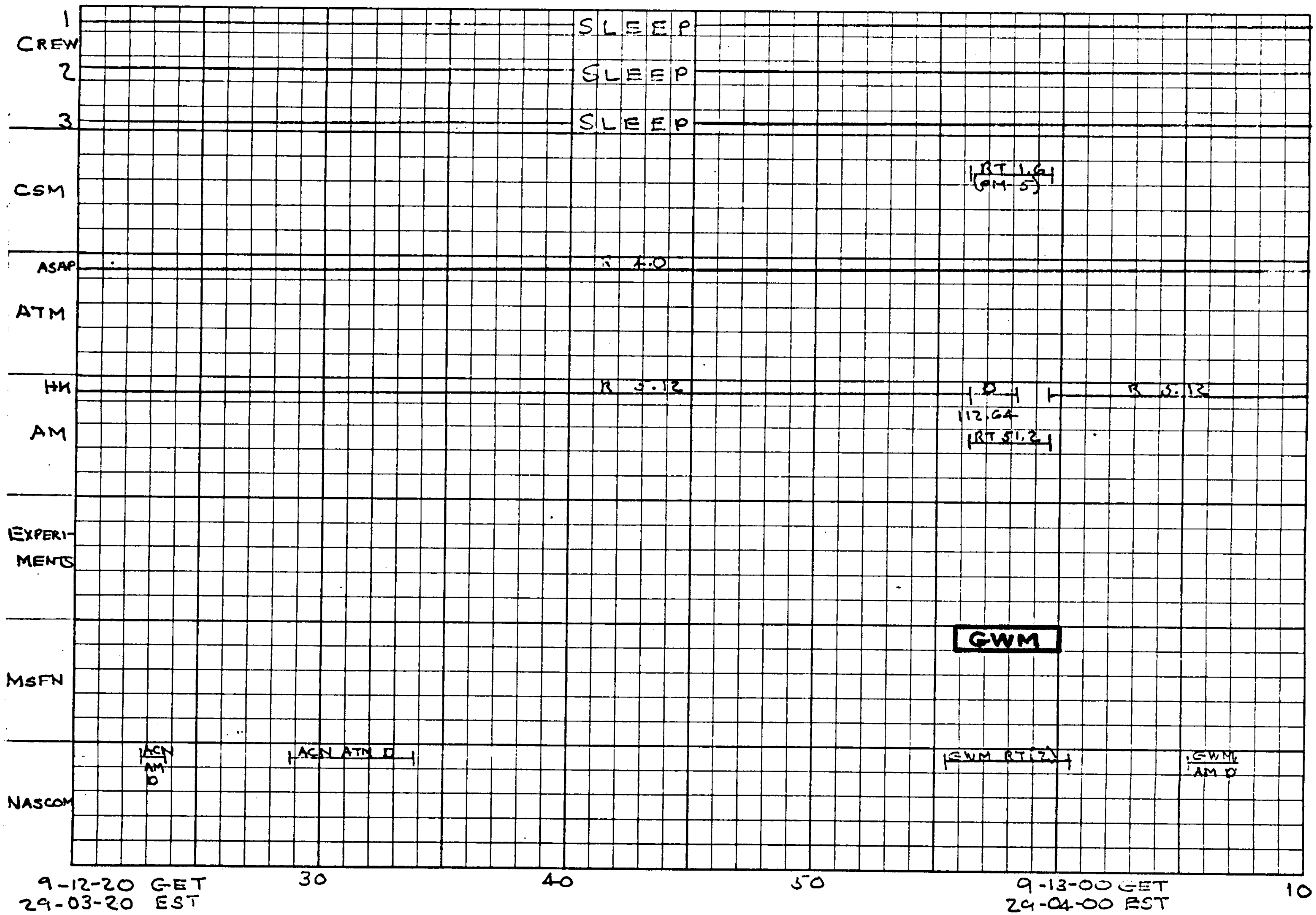

CREW
1
2
3
SLEEP
SLEEP
SLEEP
CSM
RT 1.6
(PT+5)
ASAP
R 4.0
D 72.0
ATM
RT 72.0
HK
R 51.2
AM
RT 51.2
EXPERI-MENTS
MSFN
SAN LOS 9-08-45
HAW
NASCOM
HAW PT(2)
9-09-00 GET
7-29-00-30 EST
10
20
30
40
50

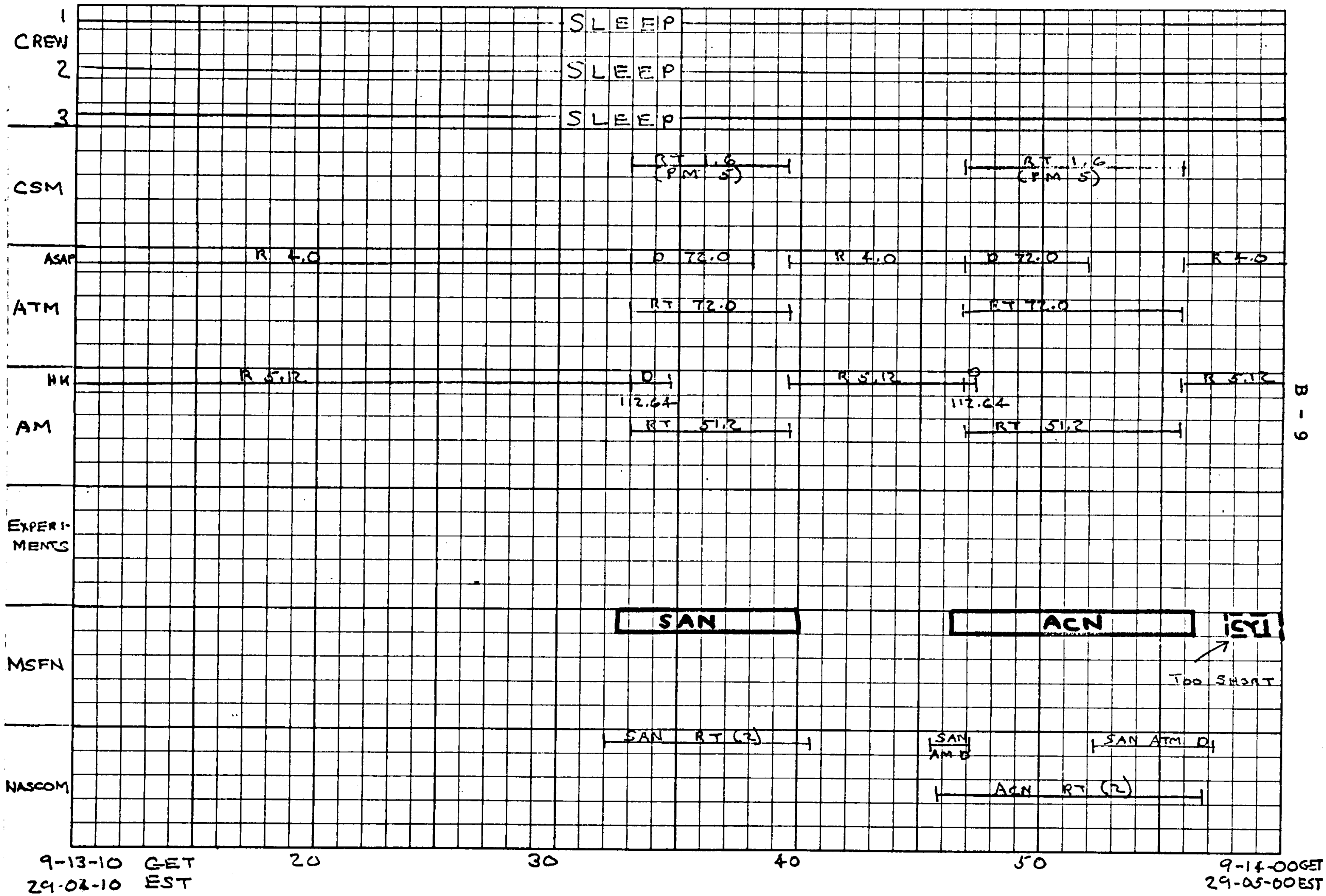


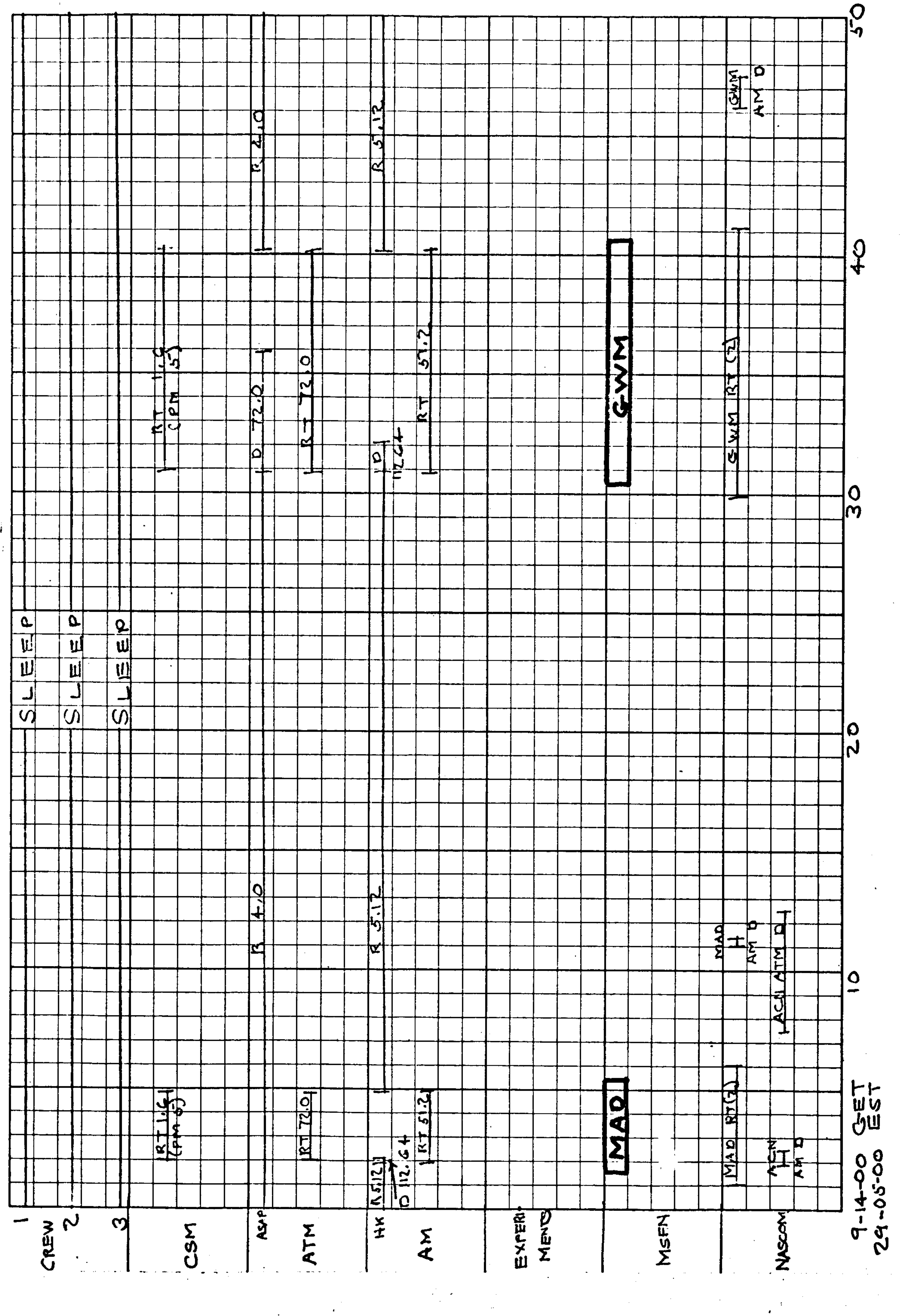
CREW
1
2
3
SLEEP
SLEEP
SLEEP
CSM
RT 1.6 (PM 3)
RT 1.6 (PM 3)
ASAP
R 1.0
D 72.0
R 1.0
ATM
RT 72.0
RT 72.0
HK
R 5.12
1.0
112.64
R 5.12
AM
RT 51.2
RT 51.2
EXPERI-MENTS
MSFN
HAW
SAN
NASCOM
HAW RT (2)
HAW AM D
HAW ATM D
SAN RT (2)
SAN AM D
SAN ATM D
9-09-30 GET
29-00-30 EST
9-10-00 GET
29-01-00 EST
10
20
30
40


CREW
1
2
3
SLEEP
SLEEP
SLEEP
CSM
RT 51.2 BNG
(PM 15)
ASAP
R 4.0
D 72.0
ATM
RT 72.0
HK
R 5.12
D 12.64
AM
RT 51.2
EXPERI-
MENTS
MSFN
HAW
NASCOM
HAW RT (2)
9-10-40 GET
29-01-40 EST
50
9-11-00 GET
29-02-00 EST
10
20
30

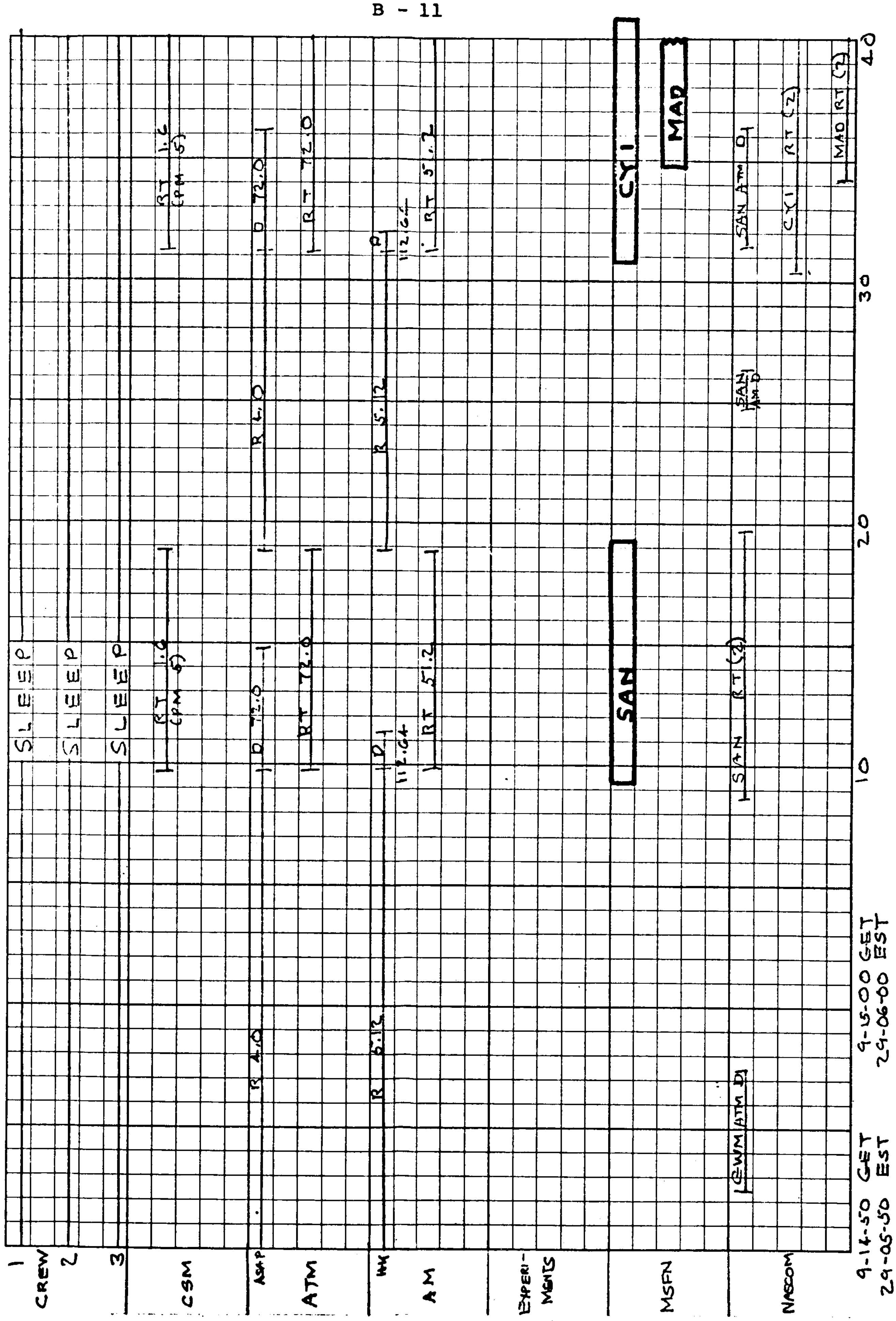

CREW
1
2
3
SLEEP
SLEEP
SLEEP
CSM
RT 51.2, RNG
RT 1.6 (PM 5)
RT 1.6 (PM 5)
ASAP
K 4.0
D 72.0
R 4.0
ATM
RT 72.0
RT 72.0
RT 72.0
HX
R 5.12
D
112.64
R 5.12
D
112.64
R 5.12
AM
RT 51.2
RT 51.2
RT 51.2
EXPERI-
MENTS
HAW
SAN
ACN
MSFN
HAW RT(2)
HAW AM D
HAW ATM D
SAN RT (2)
SAN AM D
ACN RT (2)
NASCOM
9-11-30 GET
29-02-30 EST
40
50
9-12-00 GET
29-03-00 EST
10
20

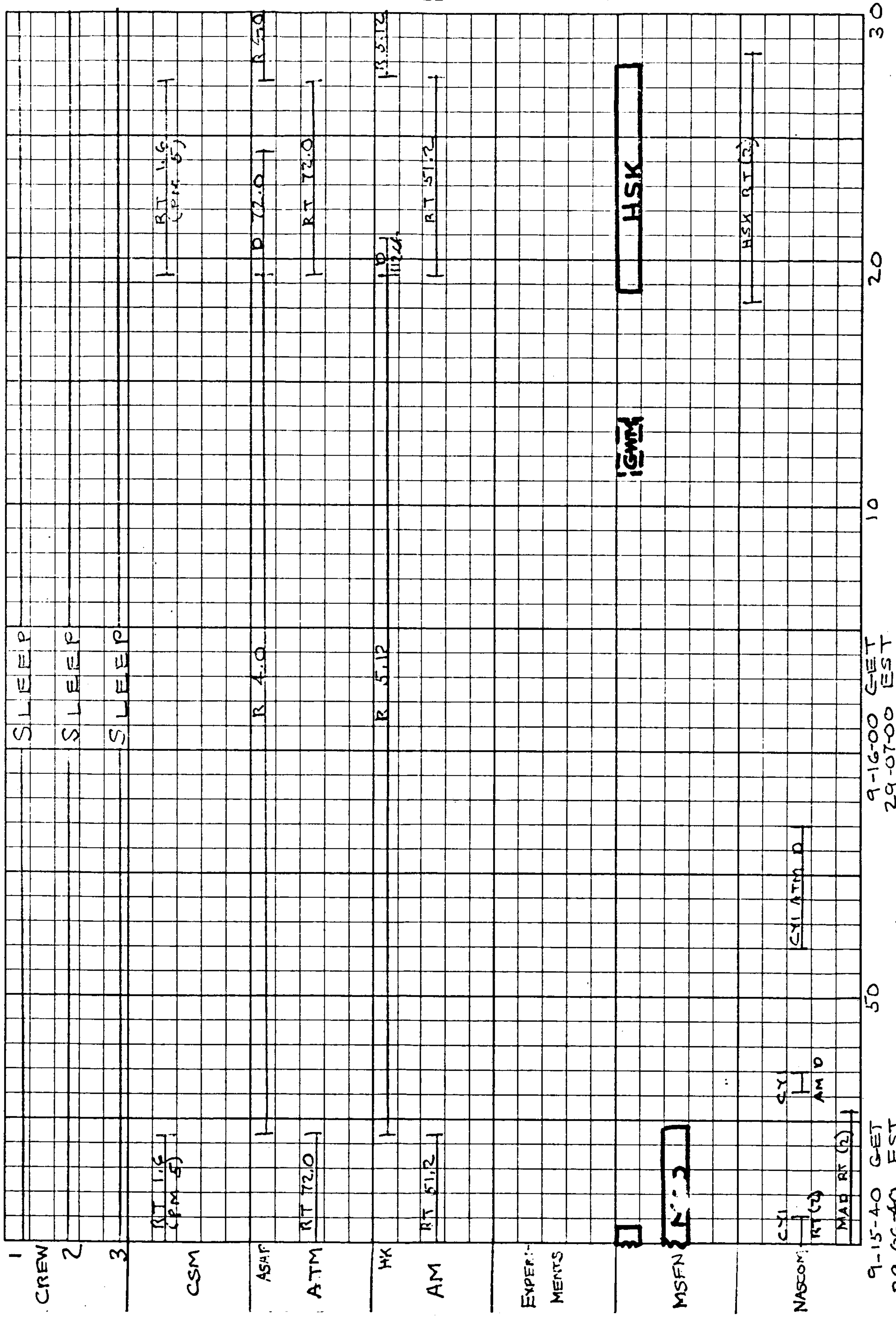

CREW
1
2
3
SLEEP
SLEEP
SLEEP
CSM
BT 1.6
(AM 5)
ASAP
ATM
R 4.0
HK
AM
R 5.12
D
112.64
BT 51.2
R 5.12
EXPERI-
MENTS
MSFN
GWM
NASCOM
ACN
AM
D
ACN ATM D
GWM RT 1.2
GWM
AM D
9-12-20 GET
29-03-20 EST
30
40
50
9-13-00 GET
29-04-00 EST
10

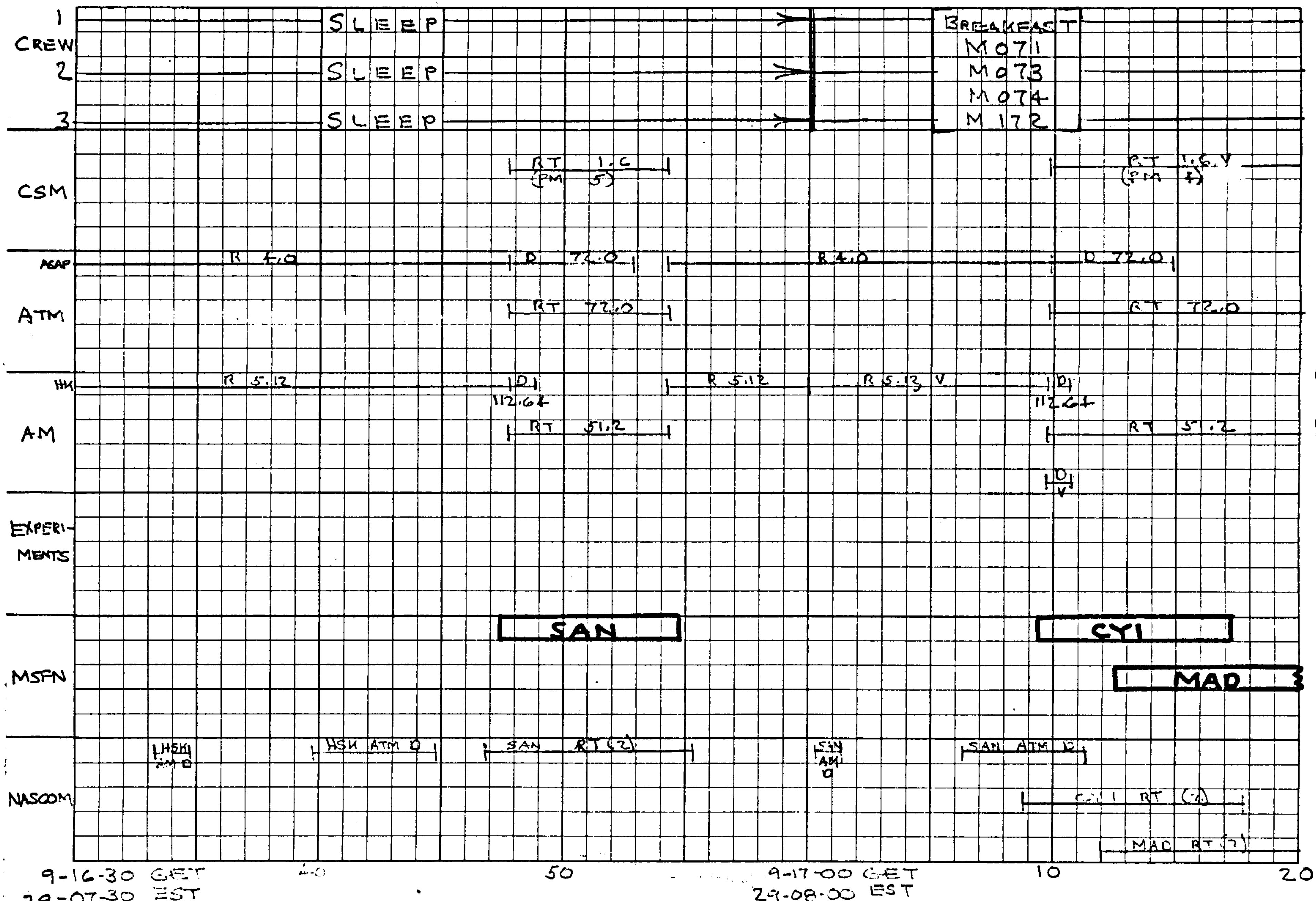

CREW
1
2
3
SLEEP
SLEEP
SLEEP
CSM
RT 1.6 (PM 5)
RT 1.6 (PM 5)
ASAP
R 4.0
D 72.0
R 4.0
D 72.0
R 4.0
ATM
RT 72.0
RT 72.0
HK
R 5.12
D
R 5.12
D
R 5.12
112.64
112.64
AM
RT 51.2
RT 51.2
EXPERI-MENTS
MSFN
SAN
ACN
CYI
TOO SHORT
NASCOM
SAN RT (2)
SAN AM D
SAN ATM D
ACN RT (2)
9-13-10 GET
29-02-10 EST
20
30
40
50
9-14-00GET
29-05-00EST



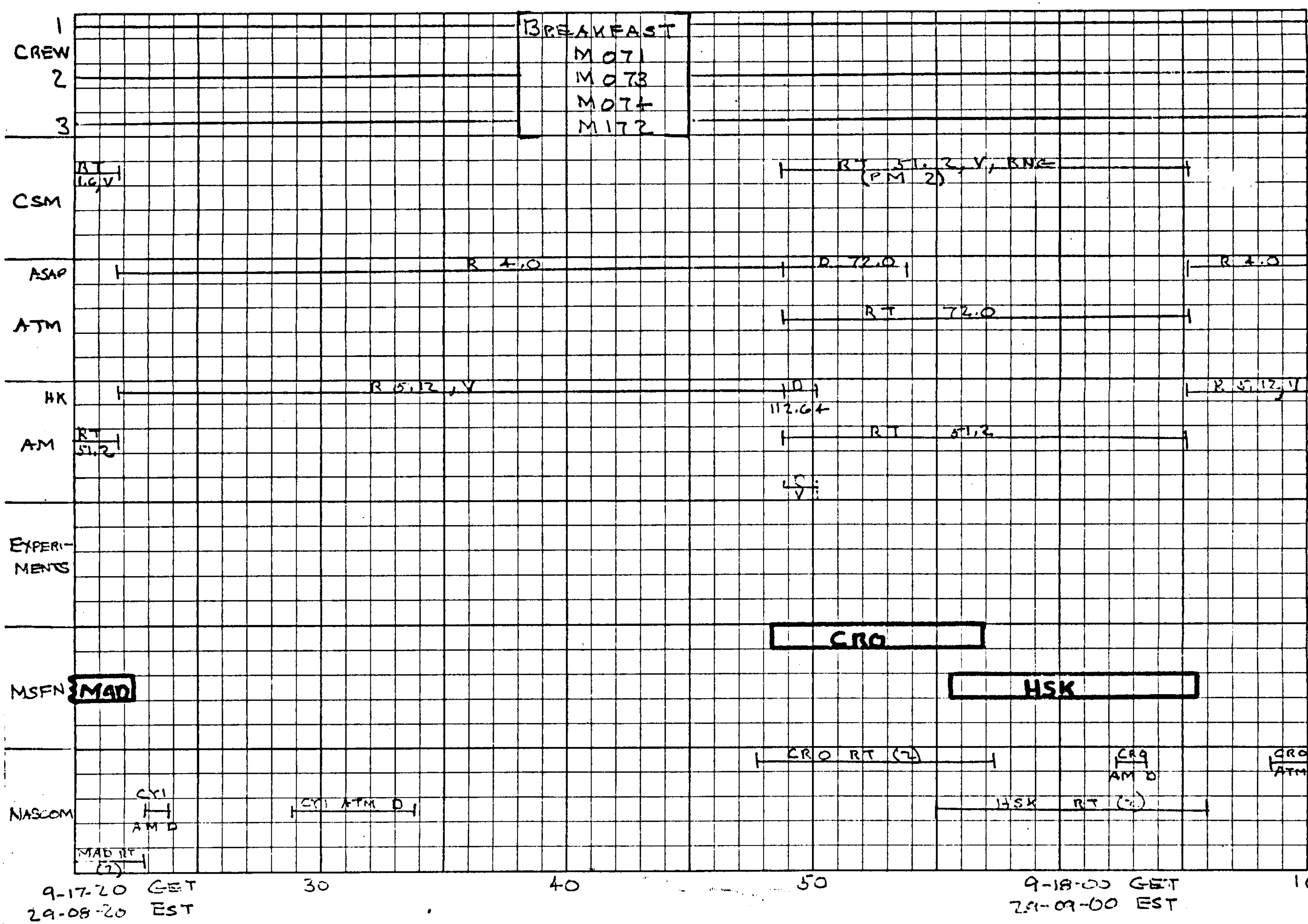
CREW
1
2
3
SLEEP
SLEEP
SLEEP
CSM
RT 1.6 (PM 5)
ASAP
R 4.0
D 72.0
ATM
RT 72.0
HK
R 5.12
AM
RT 51.2
D 112.64
EXPERIMENTS
MSFN
MAD
G-WM
NASCOM
MAD RT(2)
G-WM RT(2)
ACN
AM D
ACN ATM D
GWM
9-14-00 GET
29-05-00 EST
10
20
30
40
50


CREW
1
2
3
CSM
ASAP
ATM
AM
EXPERI-MENTS
MSFN
NASCOM
SLEEP
SLEEP
SLEEP
RT 1.6 (PM 5)
RT 1.6 (PM 5)
D 72.0
R 4.0
D 72.0
R 4.0
RT 72.0
RT 72.0
R 5.12
D
112.64
R 5.12
D
112.64
RT 51.2
RT 51.2
SAN
CY1
MAD
EWM ATM D
SAN RT (2)
SAN ATM D
SAN ATM D
CY1 RT (2)
MAD RT (2)
9-14-50 GET
29-05-50 EST
9-15-00 GET
29-06-00 EST
10
20
30
40

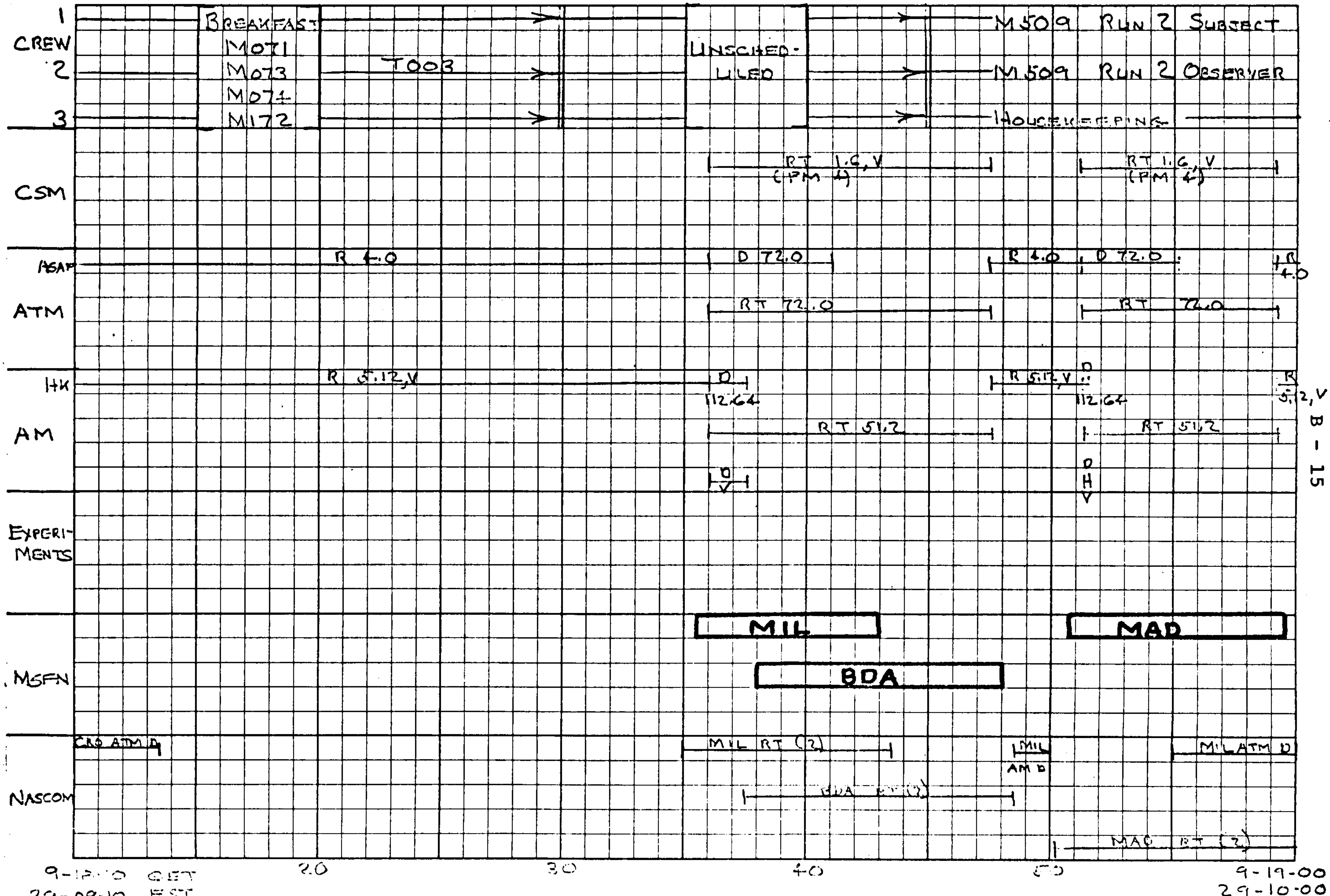

CREW
1
2
3
CSM
ASAP
ATM
HK
AM
EXPERI-
MENTS
MSFN
NASCOM
9-15-40 GET
29-06-40 EST
50
9-16-00 GET
29-07-00 EST
10
20
30
SLEEP
SLEEP
SLEEP
RT 1.6
(PM 5)
R 4.0
D 72.0
R 4.0
RT 72.0
RT 72.0
R 5.12
RT 51.2
RT 51.2
HSK
HSK RT (2)
CY1 ATM D
CY1
AM D
MAB RT (2)
RT (2)

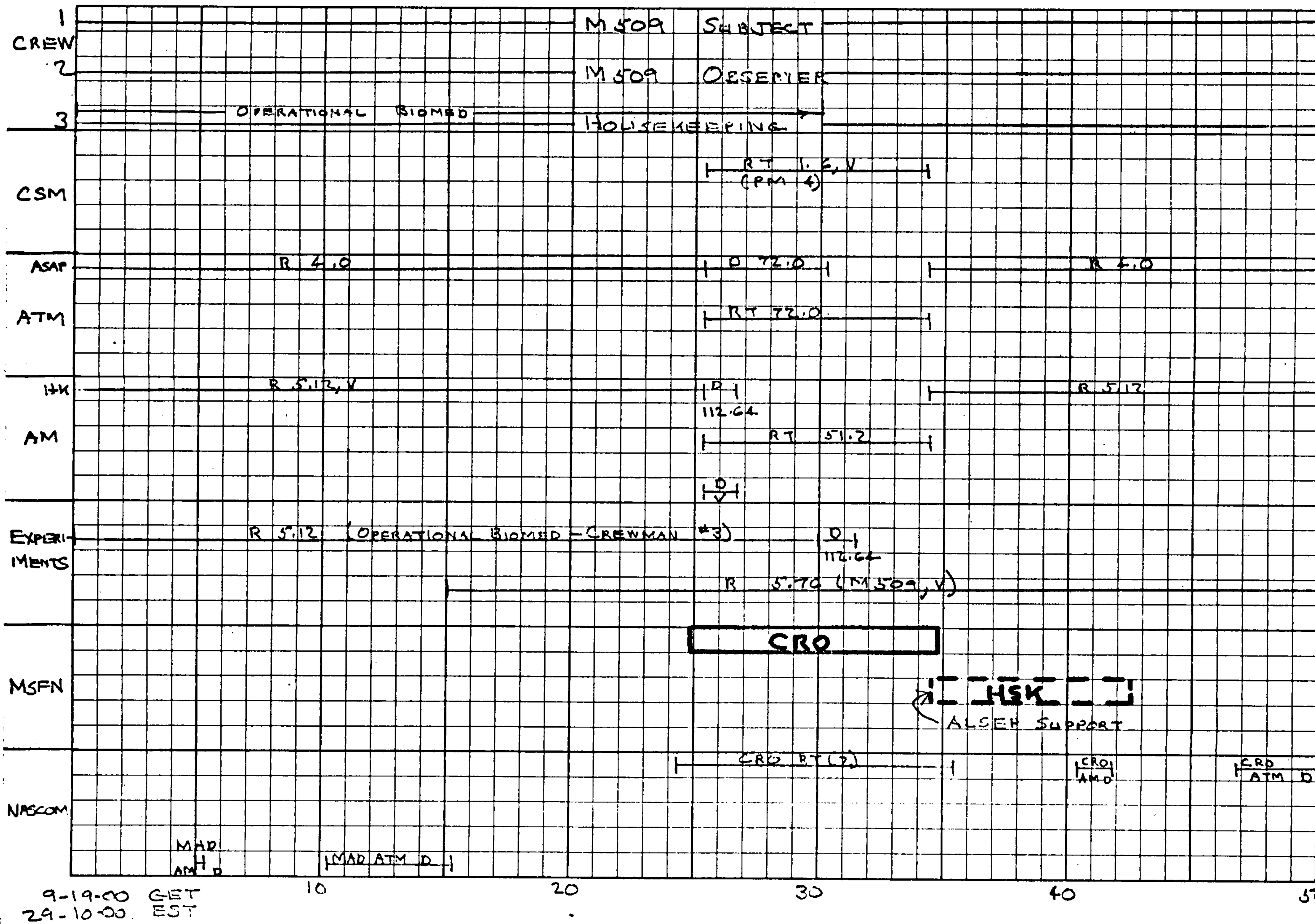


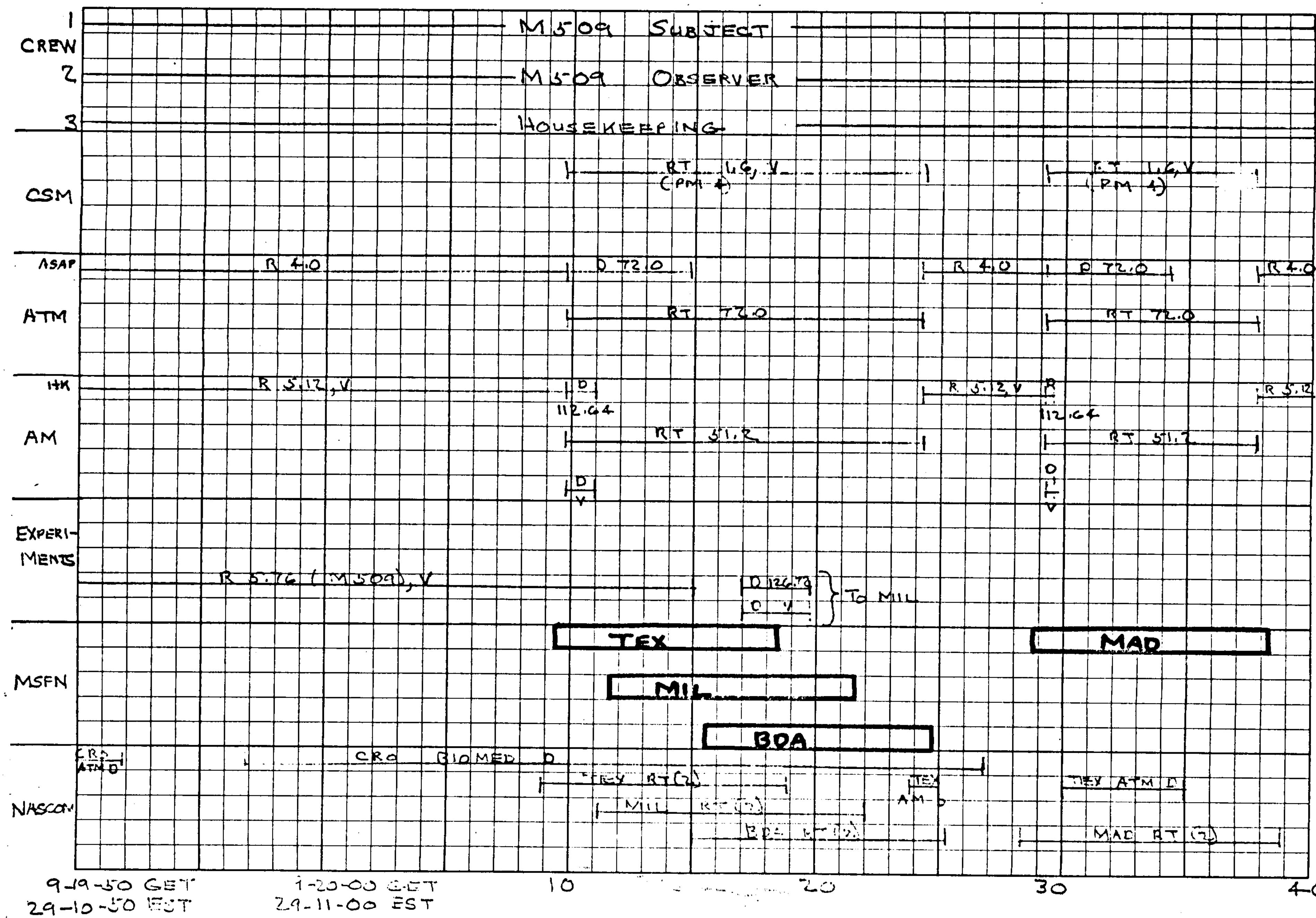
CREW
1
2
3
SLEEP
SLEEP
SLEEP
BREAKFAST
M071
M073
M074
M172
CSM
RT 1.6
(PM 5)
RT 1.6 V
(PM 4)
ASAP
R 4.0
D 72.0
R 4.0
D 72.0
ATM
RT 72.0
RT 72.0
HK
R 5.12
D
112.64
R 5.12
R 5.13 V
D
112.64
AM
RT 51.2
RT 51.2
D
V
EXPERI-
MENTS
MSFN
SAN
CYI
MAD
NASCOM
HSK
AM D
HSK ATM D
SAN RT (2)
SAN
AM
D
SAN ATM D
RT
MAD RT (2)
9-16-30 GET
29-07-30 EST
50
9-17-00 GET
29-08-00 EST
10
20

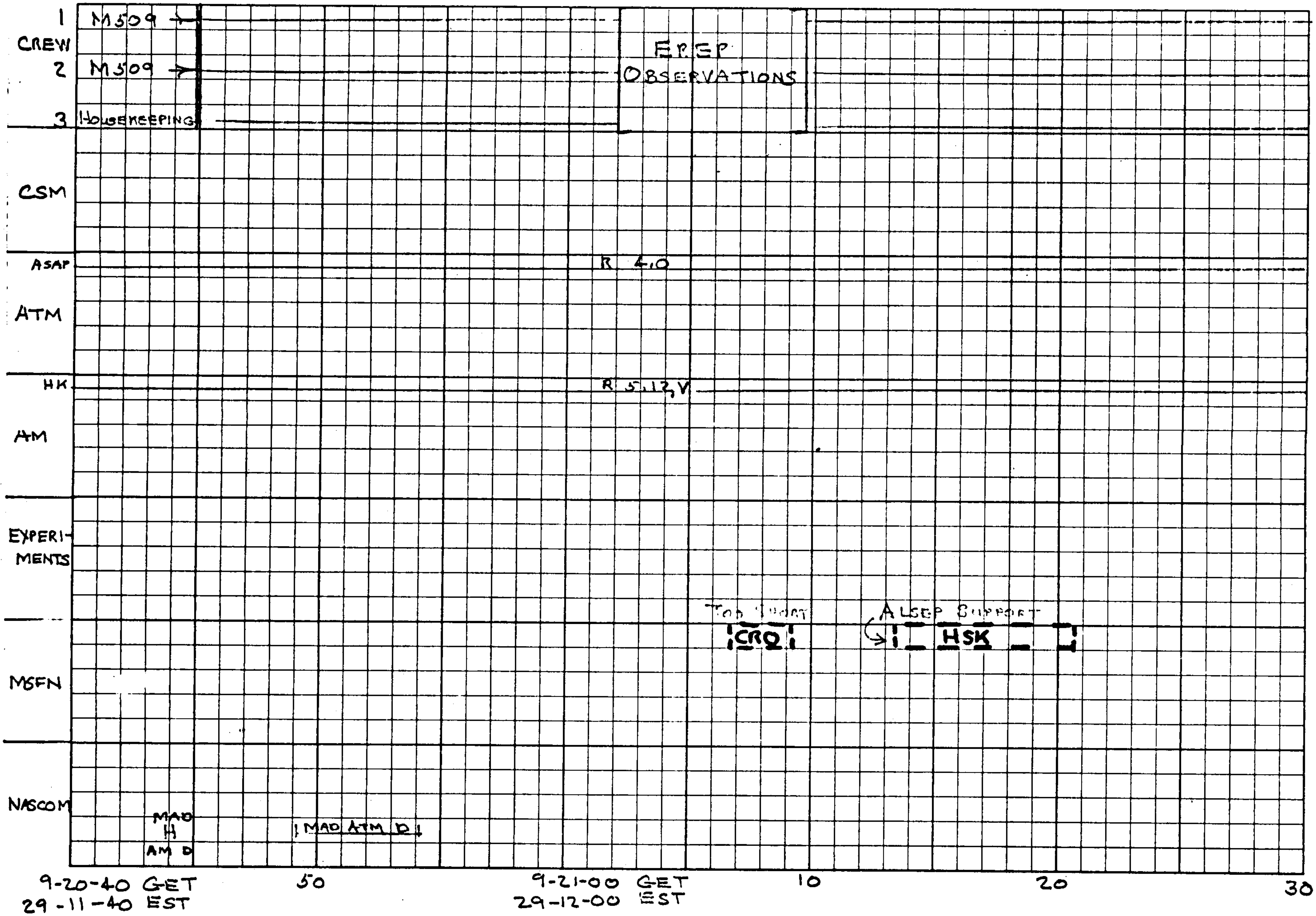


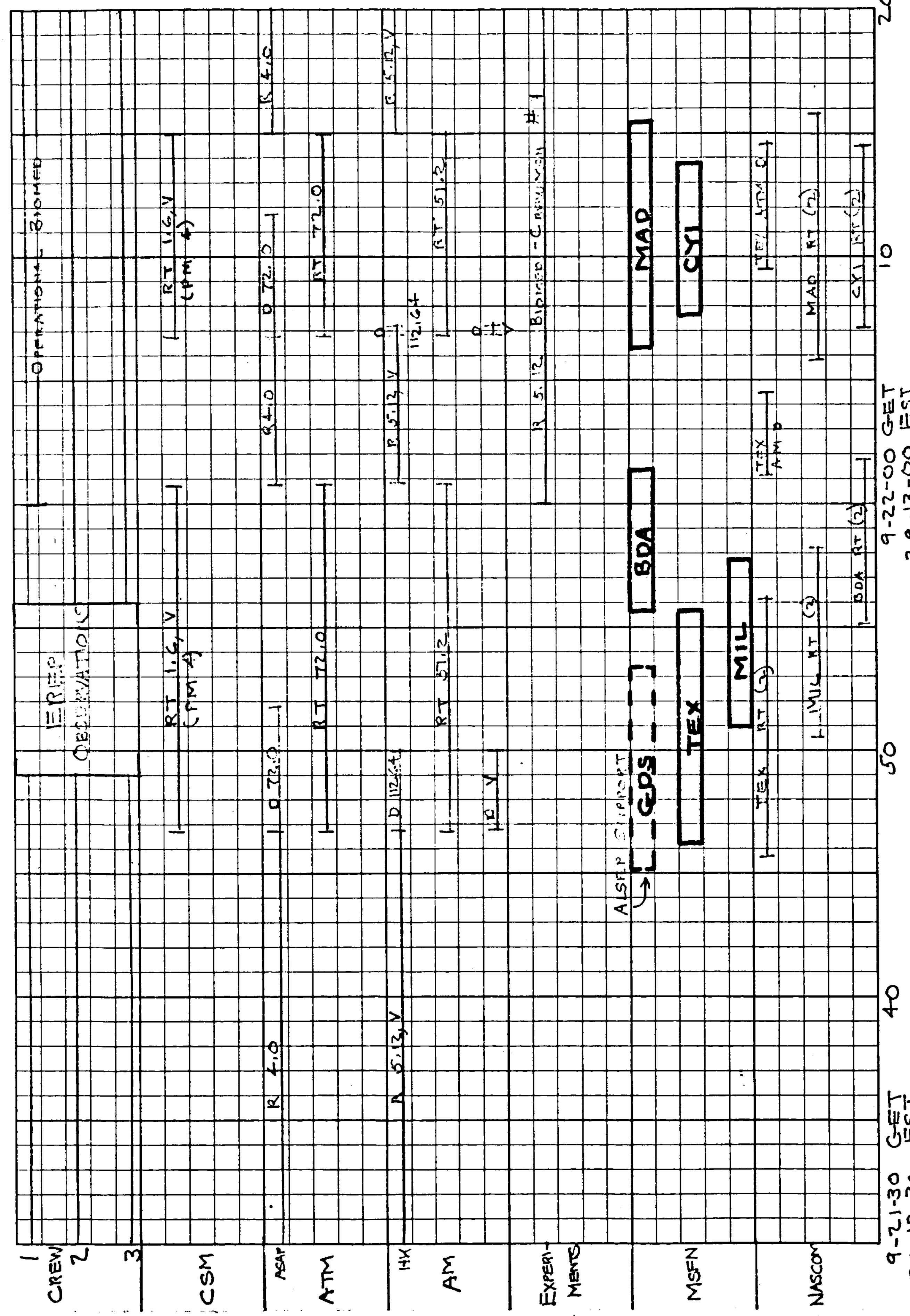
CREW
1
2
3
BREAKFAST
M071
M073
M074
M172
CSM
RT 1.6, V
RT 51.2, V, RNG (PM 2)
ASAP
R 4.0
D 72.0
R 4.0
ATM
RT 72.0
HK
R 5.12, V
D 112.64
R 5.12, V
AM
RT 51.2
RT 51.2
V
EXPERI-MENTS
MSFN
MAD
CRO
HSK
NASCOM
CYI AM D
CYI ATM D
CRO RT (2)
CRO AM D
CRO ATM D
HSK RT (2)
MAD RT (2)
9-17-20 GET
29-08-20 EST
30
40
50
9-18-00 GET
29-09-00 EST
10

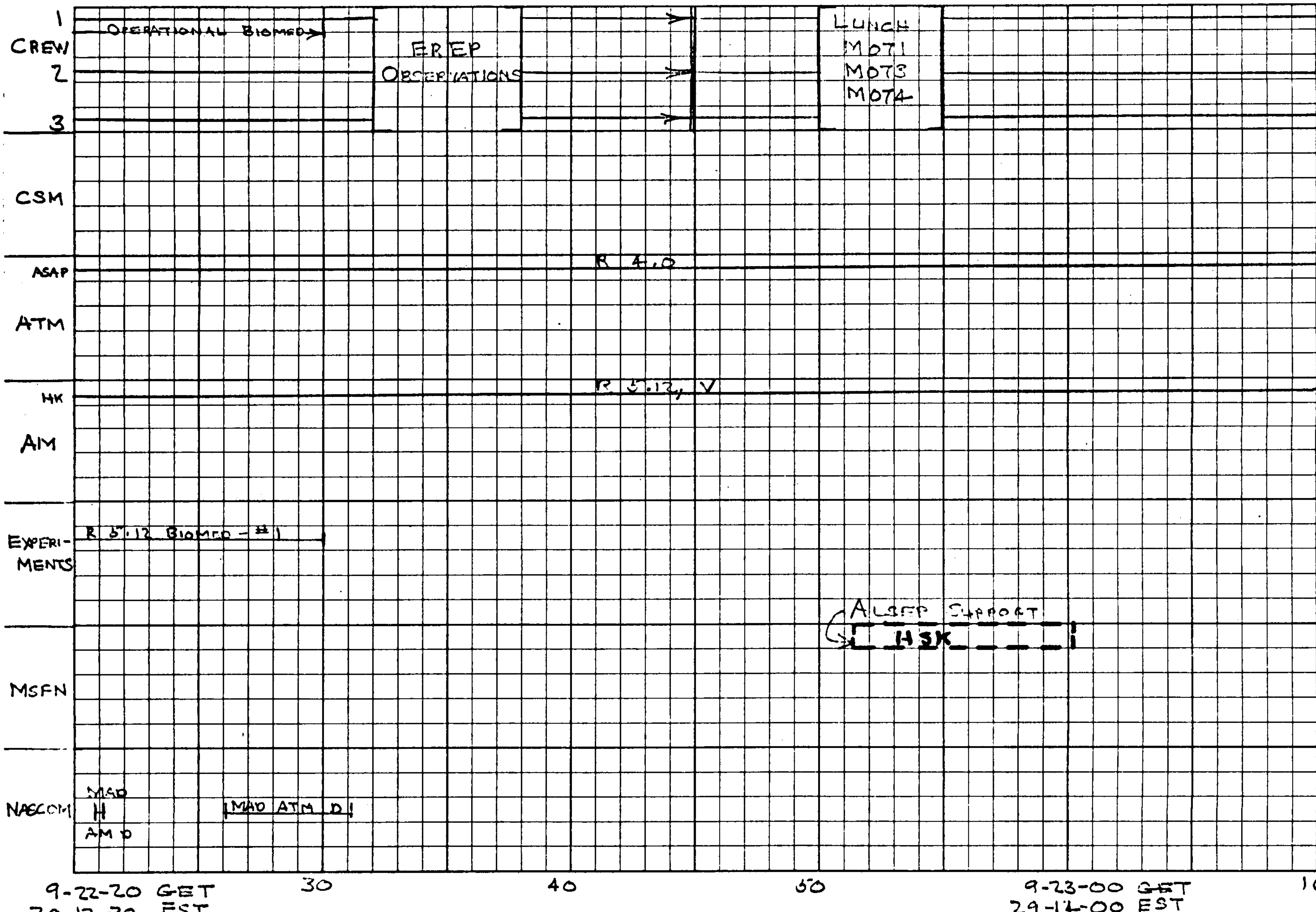

CREW
1
2
3
CSM
ASAP
ATM
HK
AM
EXPERI-MENTS
MSFN
NASCOM
BREAKFAST
M071
M073
M074
M172
T003
UNSCHED-ULED
M509 RUN 2 SUBJECT
M509 RUN 2 OBSERVER
HOUSEKEEPING
RT 1.6,V (PM 4)
R 4.0
D 72.0
RT 72.0
R 5.12,V
D 112.64
RT 51.2
D V
D H V
MIL
MAD
BDA
CRO ATM D
MIL RT (2)
MIL AM D
BDA RT (2)
MIL ATM D
MAD RT (2)
9-19-00 GET
29-09-10 EST
20
30
40
50
9-19-00
29-10-00

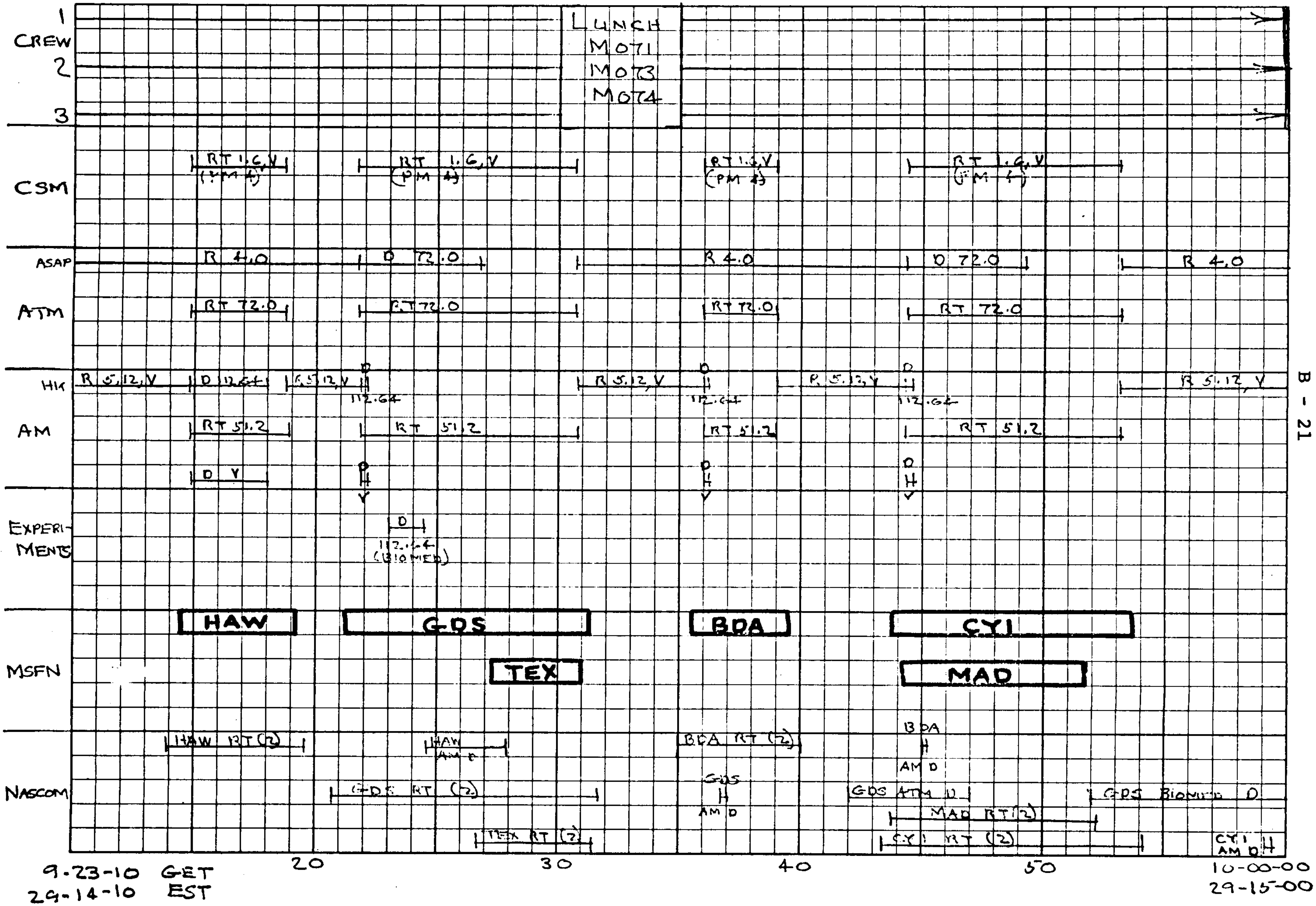

CREW
1
2
3
M 509 SUBJECT
M 509 OBSERVER
OPERATIONAL BIOMED
HOUSEKEEPING
CSM
RT 1.6, V
(PM 4)
ASAP
R 4.0
D 72.0
R 4.0
ATM
RT 72.0
HK
R 5.12, V
D
112.64
R 5.12
AM
RT 51.2
D
V
EXPERIMENTS
R 5.12 (OPERATIONAL BIOMED - CREWMAN #3)
D
112.64
R 5.76 (M 509, V)
MSFN
CRO
HSK
ALSEP SUPPORT
NASCOM
CRO RT (?)
CRO
AMD
CRO
ATM D
MAD
AM D
MAD ATM D
9-19-00 GET
29-10-00 EST
10
20
30
40
50

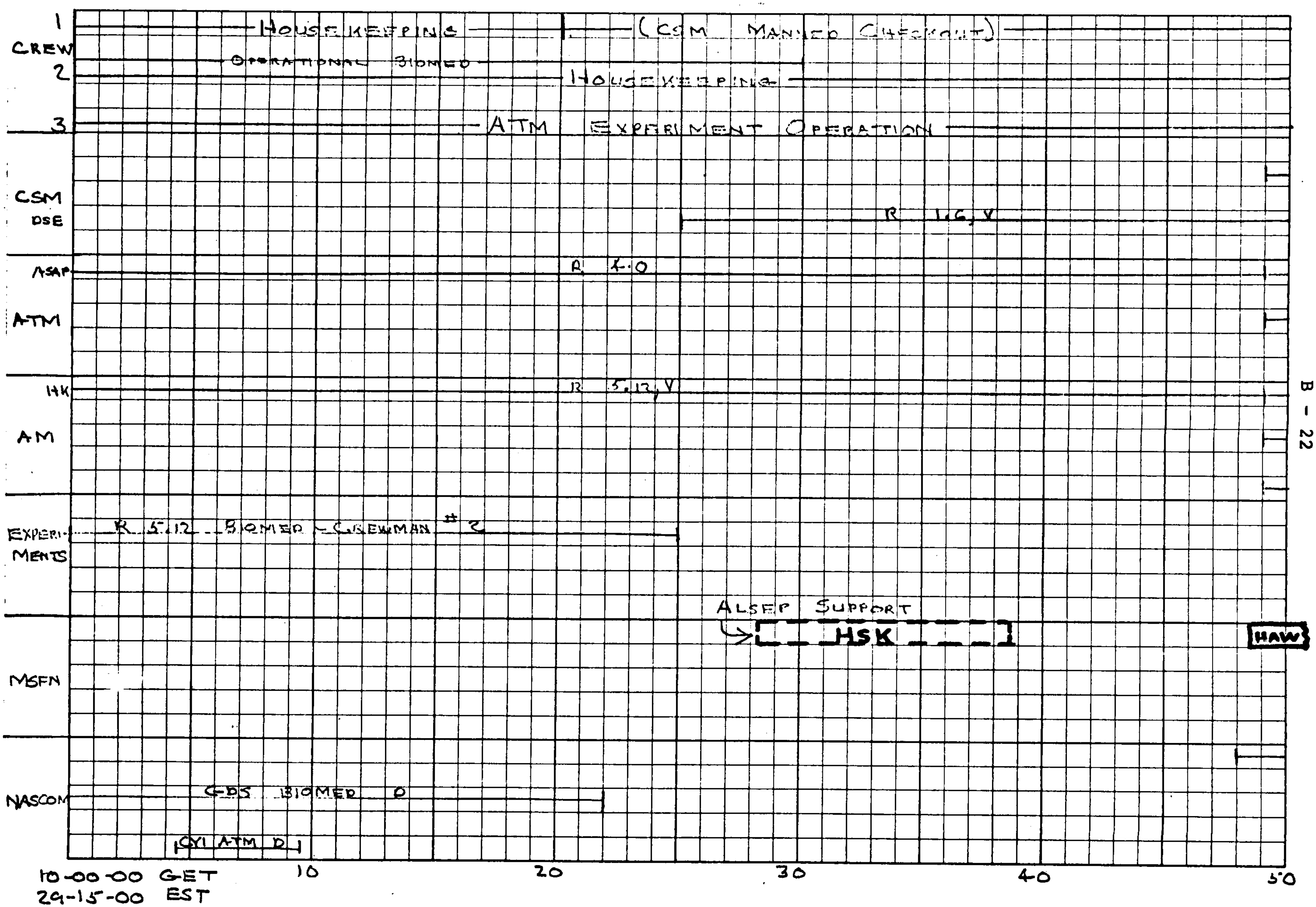

CREW
1
2
3
M509 SUBJECT
M509 OBSERVER
HOUSEKEEPING
CSM
RT 1.6, V
(PM 4)
ASAP
R 4.0
D 72.0
ATM
RT 72.0
H+K
R 5.12, V
D
112.64
AM
RT 51.2
D
V
EXPERI-MENTS
R 5.76 (M509), V
D 126.72
D V
TO MIL
MSFN
TEX
MIL
BDA
MAD
NASCOM
CRO ATM D
CRO BIOMED D
TEX RT (2)
MIL RT (2)
BDA RT (2)
TEX AM D
TEX ATM D
MAD RT (2)
9-19-50 GET
29-10-50 EST
1-20-00 GET
29-11-00 EST
10
20
30
40

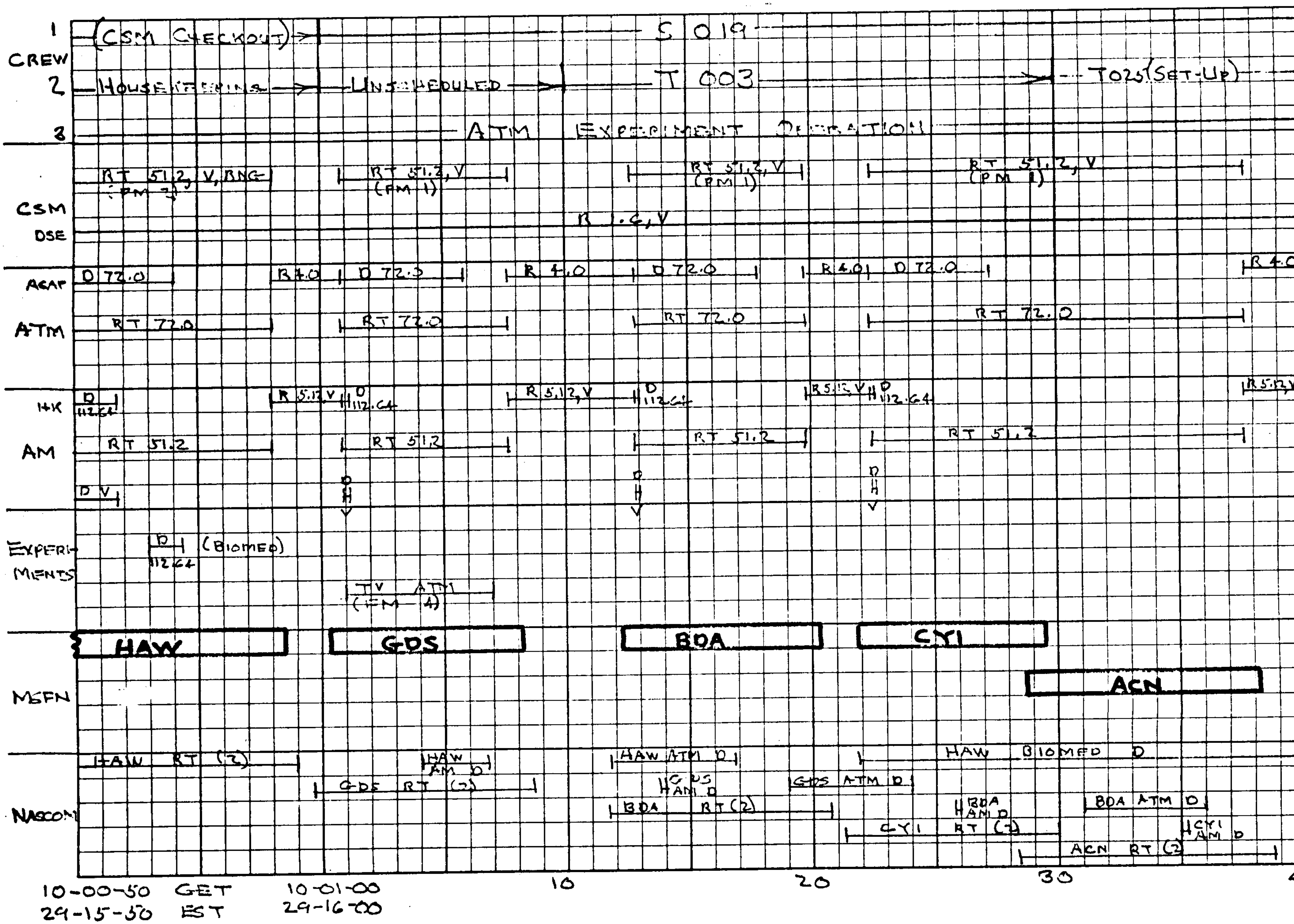

CREW
1 M509
2 M509
3 HOUSEKEEPING
EREP OBSERVATIONS
CSM
ASAP
ATM
R 4.0
HK
AM
R 5,12,V
EXPERI-MENTS
ALSEP SUPPORT
CRO
HSK
MSFN
NASCOM
MAD H
AM D
MAD ATM D
9-20-40 GET
29-11-40 EST
50
9-21-00 GET
29-12-00 EST
10
20
30

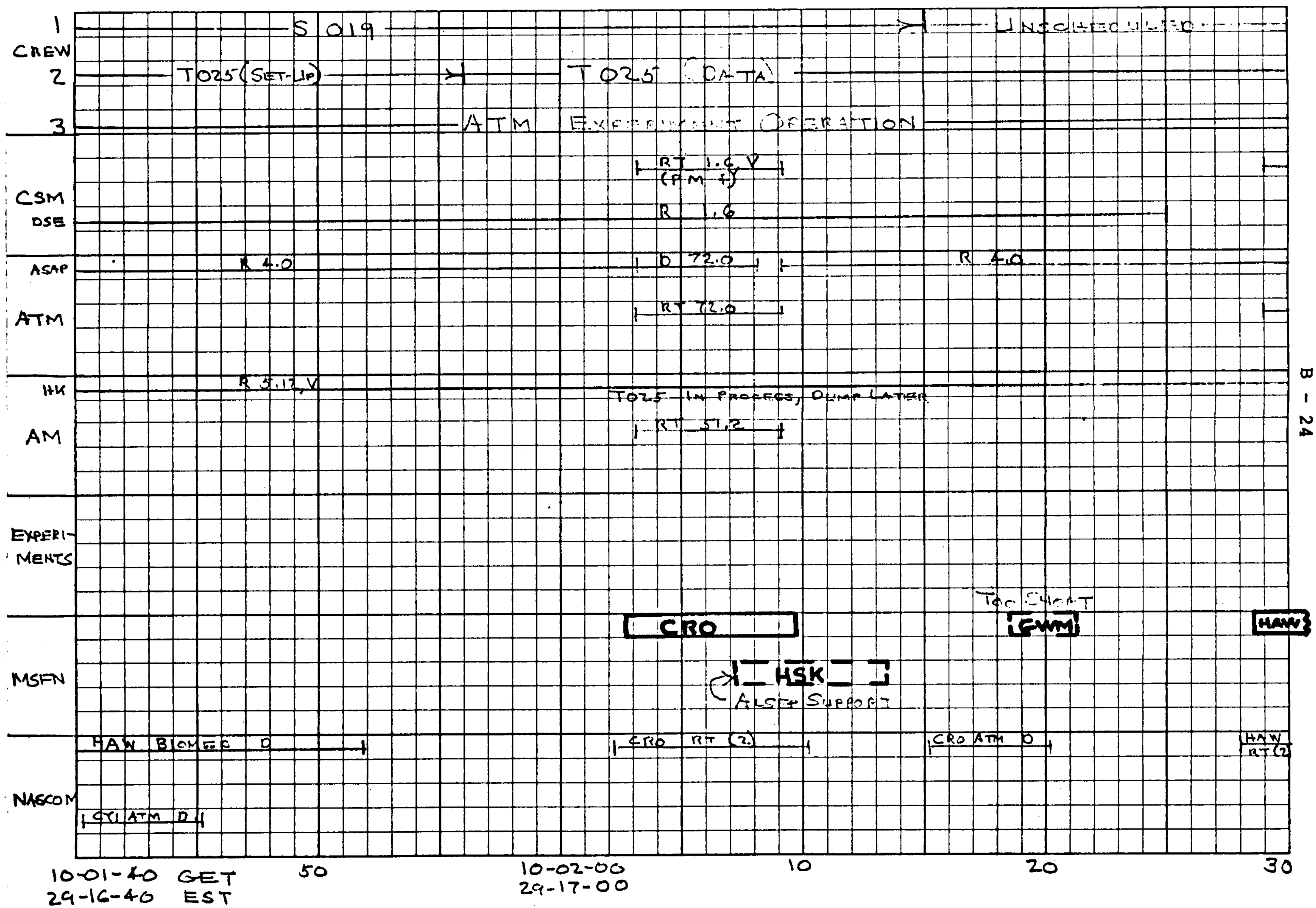

CREW
1
2
3
CSM
ASAP
ATM
1K
AM
EXPERI-MENTS
MSFN
NASCOM
9-21-30 GET
29-12-30 EST
40
50
9-22-00 GET
29-13-00 EST
10
20
EREP OBSERVATIONS
OPERATIONAL BIOMED
RT 1.6, V (PM 4)
R 4.0
D 72.0
RT 72.0
R 5.13, V
D 112.64
R 5.12, V
RT 51.2
D V
R 5.12
ALSEP SUPPORT
GDS
TEX
MIL
BDA
MAP
CY1
TEX RT (2)
MIL RT (2)
BDA RT (2)
MAD RT (2)
CY1 RT (2)

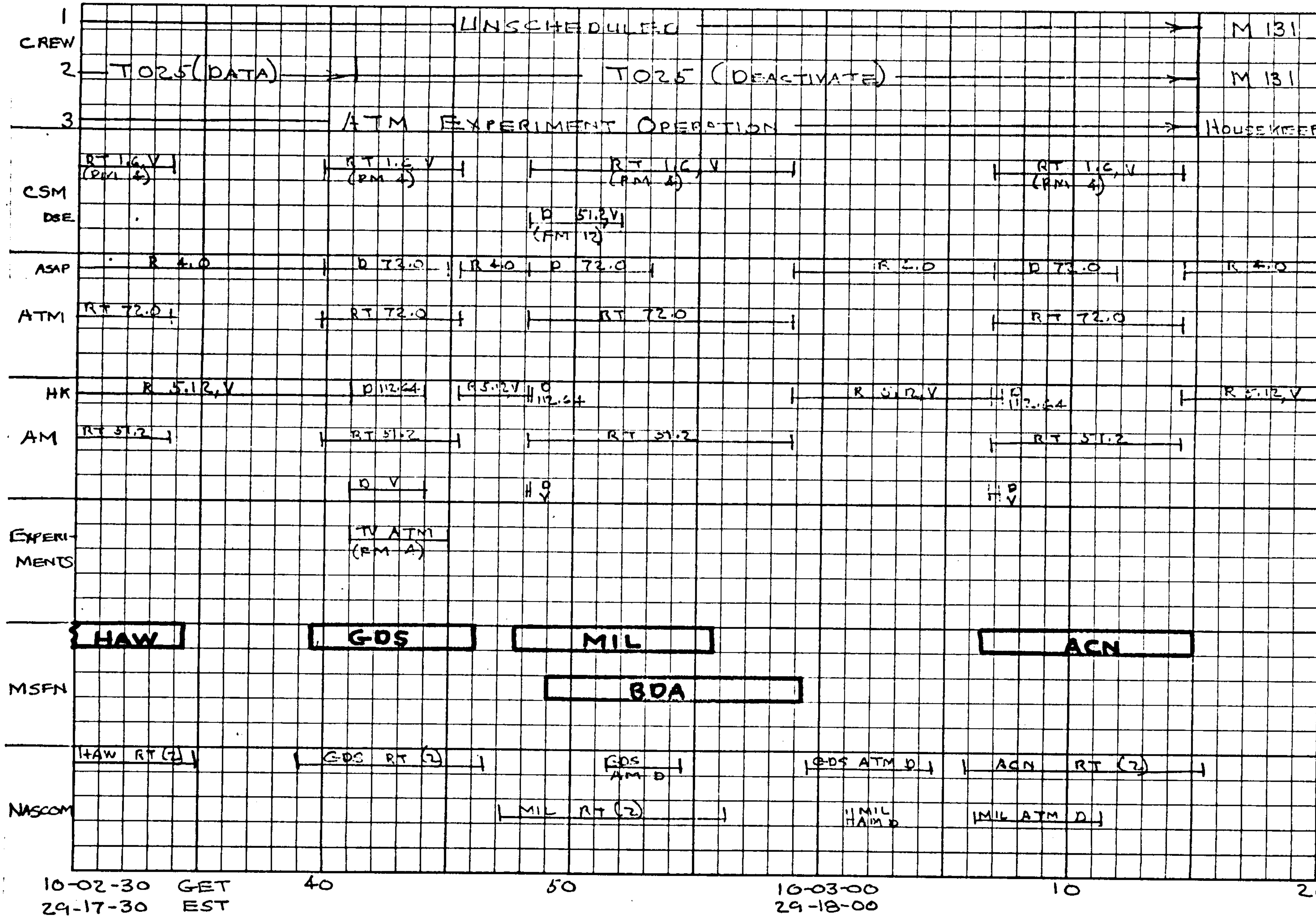

CREW
1
2
3
OPERATIONAL BIOMED
EREP
OBSERVATIONS
LUNCH
M071
M073
M074
CSM
ASAP
ATM
R 4.0
HK
AM
R 5.12, V
EXPERI-
MENTS
R 5.12 BIOMED - #1
ALSEP SUPPORT
HSK
MSFN
NASCOM
MAD
H
AM D
MAD ATM D
9-22-20 GET
29-13-20 EST
30
40
50
9-23-00 GET
29-14-00 EST
10

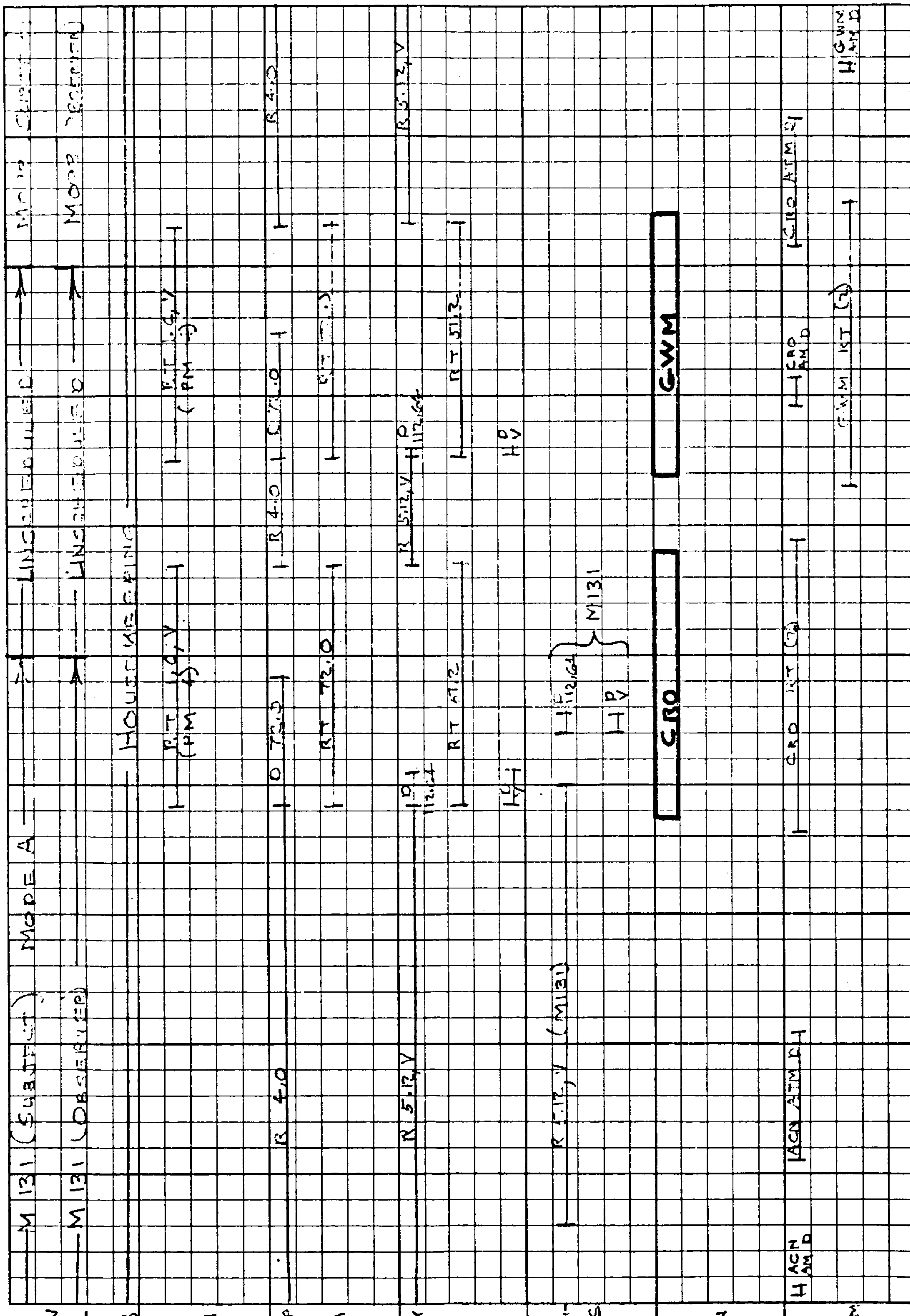

CREW
1
2
3
LUNCH
M071
M073
M074
CSM
RT 1.6,V (PM 4)
RT 1.6,V (PM 4)
RT 1.6,V (PM 4)
RT 1.6,V (PM 4)
ASAP
R 4.0
D 72.0
R 4.0
D 72.0
R 4.0
ATM
RT 72.0
RT 72.0
RT 72.0
RT 72.0
HK
R 5.12,V
D 12.64
R 5.12,V
D
112.64
R 5.12,V
D
112.64
R 5.12,V
D
112.64
R 5.12,V
AM
RT 51.2
RT 51.2
RT 51.2
RT 51.2
D Y
D
H
Y
EXPERIMENTS
D
112.64
(BIOMED)
MSFN
HAW
GDS
TEX
BDA
CYI
MAD
NASCOM
HAW RT (2)
HAW
AM D
GDS RT (2)
TEX RT (2)
BDA RT (2)
GDS
AM D
BDA
AM D
GDS ATM D
MAD RT (2)
CYI RT (2)
GDS BIOMED D
CYI
AM D
9-23-10 GET
29-14-10 EST
20
30
40
50
10-00-00
29-15-00

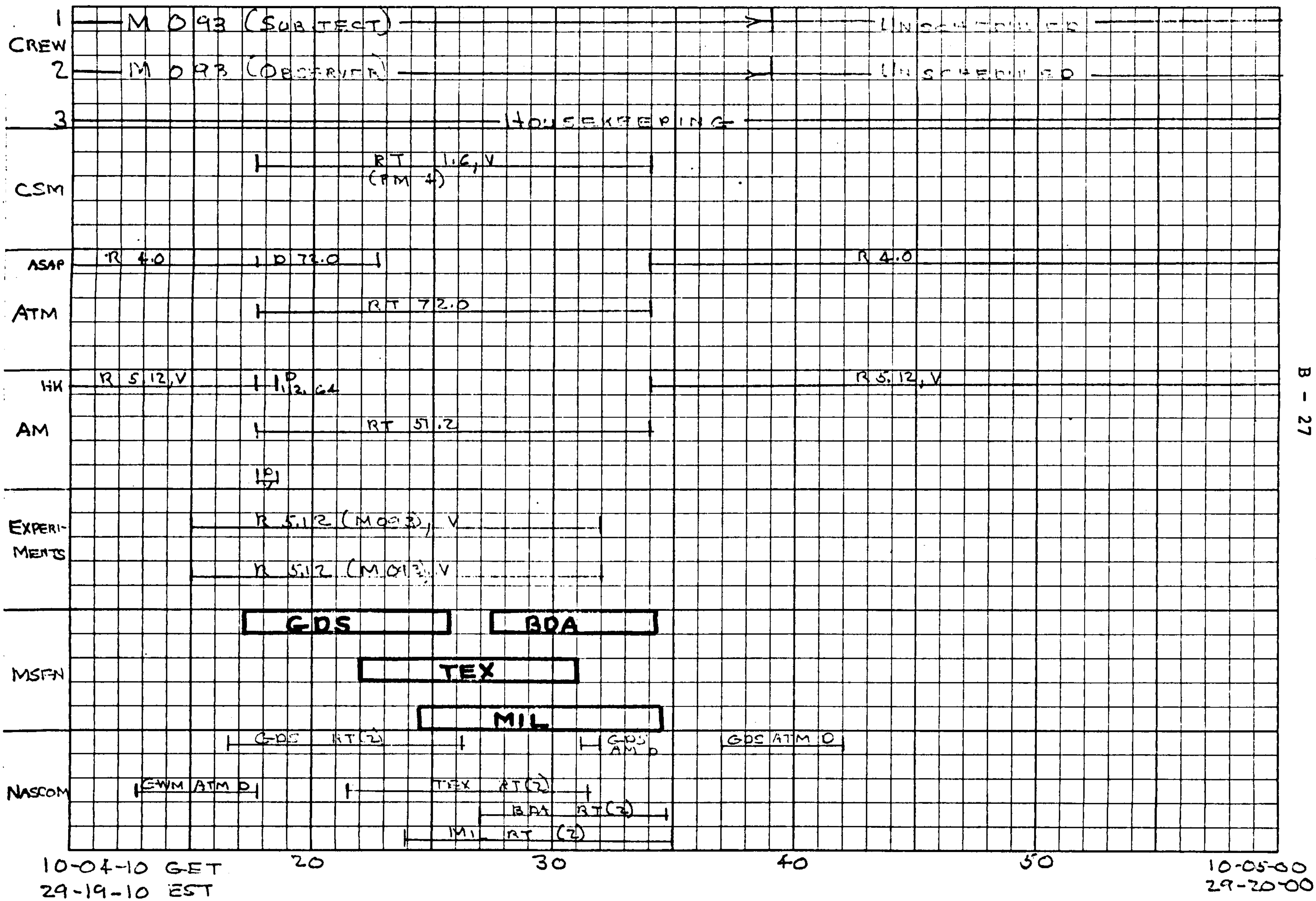

CREW
1
2
3
HOUSEKEEPING
(CSM MANNED CHECKOUT)
OPERATIONAL BIOMED
HOUSEKEEPING
ATM EXPERIMENT OPERATION
CSM
DSE
R 1.6, V
ASAP
R 4.0
ATM
HK
R 5.12, V
AM
EXPERI-
MENTS
R 5.12 BIOMED - CREWMAN # 2
ALSEP SUPPORT
HSK
HAW
MSFN
NASCOM
GDS BIOMED D
CYI ATM D
10-00-00 GET
29-15-00 EST
10
20
30
40
50


CREW
1
2
3
(CSM CHECKOUT)
S 019
T 003
T025 (SET-UP)
ATM EXPERIMENT OPERATION
CSM
DSE
RT 51.2, V, RNG
RT 51.2, V
(PM 1)
R 1.6, V
ACAP
D 72.0
R 4.0
ATM
RT 72.0
14K
AM
R 5.12, V
D
112.64
RT 51.2
D V
EXPERI-
MENTS
(BIOMED)
TV ATM
(FM 4)
MSFN
HAW
GDS
BDA
CYI
ACN
NASCOM
HAW RT (2)
HAW AM D
GDS RT (2)
HAW ATM D
BDA RT (2)
GDS ATM D
CYI RT (2)
HAW BIOMED D
BDA ATM D
ACN RT (2)
10
20
30
40
10-00-50 GET
29-15-50 EST
10-01-00
29-16-00

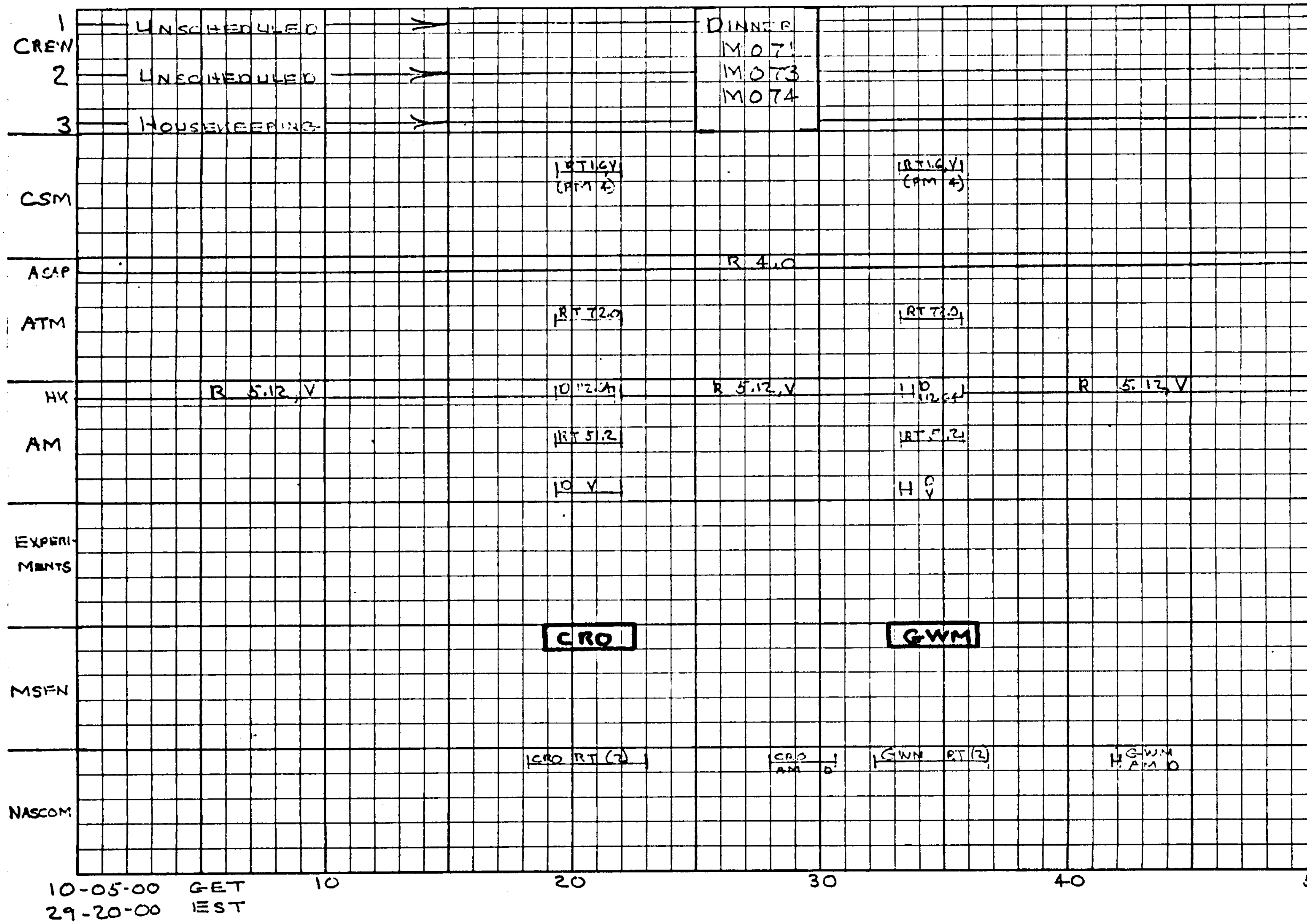

1
CREW
2
3
S 019
UNSCHEDULED
T025 (SET-UP)
T025 (DATA)
ATM EXPERIMENT OPERATION
CSM
DSE
RT 1.6 V
(PM +)
R 1.6
ASAP
R 4.0
D 72.0
R 4.0
ATM
RT 72.0
HK
R 5.12 V
T025 IN PROCESS, DUMP LATER
AM
RT 51.2
EXPERI-
MENTS
MSFN
CRO
TOO SHORT
GWM
HAW
HSK
ALSEP SUPPORT
NASCOM
HAW BIOMED D
CRO RT (2)
CRO ATM D
HAW RT (2)
CYI ATM D
10-01-40 GET
29-16-40 EST
50
10-02-00
29-17-00
10
20
30

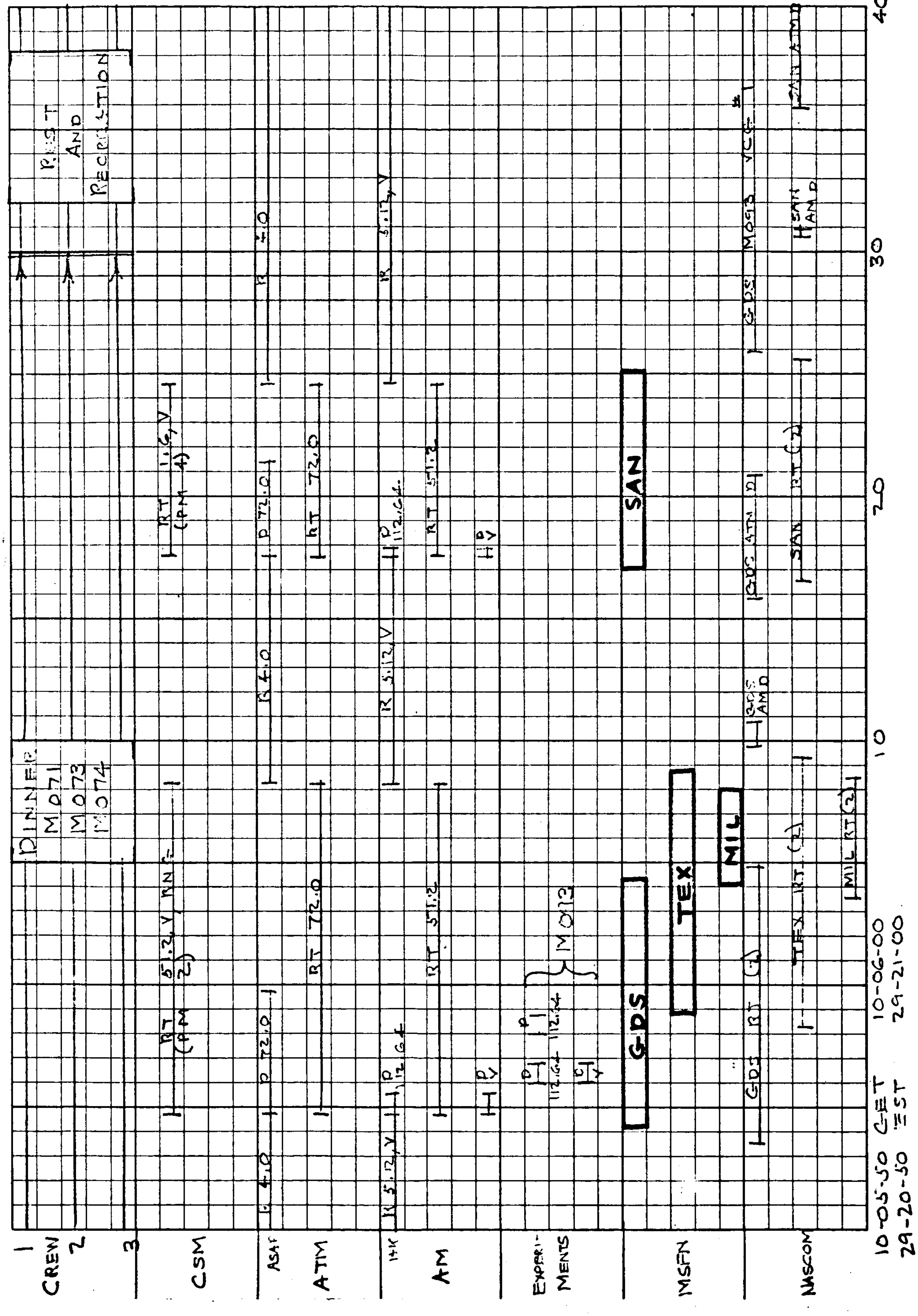

CREW
1
2
3
UNSCHEDULED
M 131
T025 (DATA)
T025 (DEACTIVATE)
M 131
ATM EXPERIMENT OPERATION
HOUSEKEEP
CSM
DSE
RT 1.6, V (RM 4)
D 51.2 V (FM 12)
ASAP
R 4.0
D 72.0
ATM
RT 72.0
HK
R 5.12, V
D 112.64
AM
RT 51.2
EXPERI-MENTS
D V
TV ATM (RM 4)
MSFN
HAW
GDS
MIL
BDA
ACN
NASCOM
HAW RT (2)
GDS RT (2)
GDS AM D
GDS ATM D
ACN RT (2)
MIL RT (2)
MIL ATM D
10-02-30 GET
29-17-30 EST
40
50
10-03-00
29-18-00
10
20

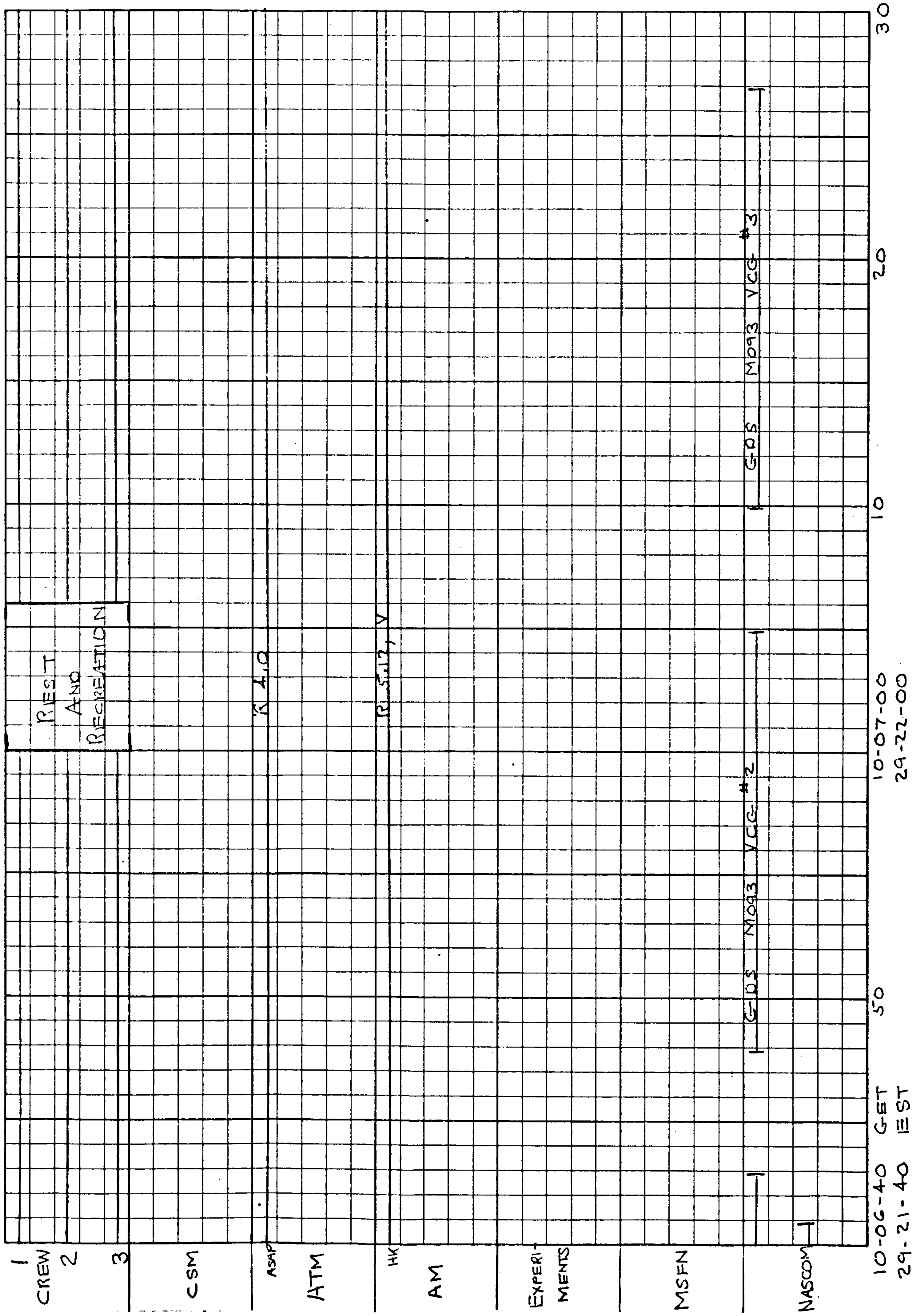

CREW
1
2
3
CSM
ASAP
ATM
HK
AM
EXPERIMENTS
MSFN
NASCOM
M 131 (SUBJECT) MODE A
M 131 (OBSERVER)
UNSCHEDULED
HOUSEKEEPING
R 4.0
RT 72.0
R 5.12,V
RT 512
R 4.0
(M131)
M131
CRO
GWM
ACN ATM D
CRO ATM D
ACN AM D
10-03-20 GET
29-18-20 EST
30
40
50
10-04-00
29-19-00
10

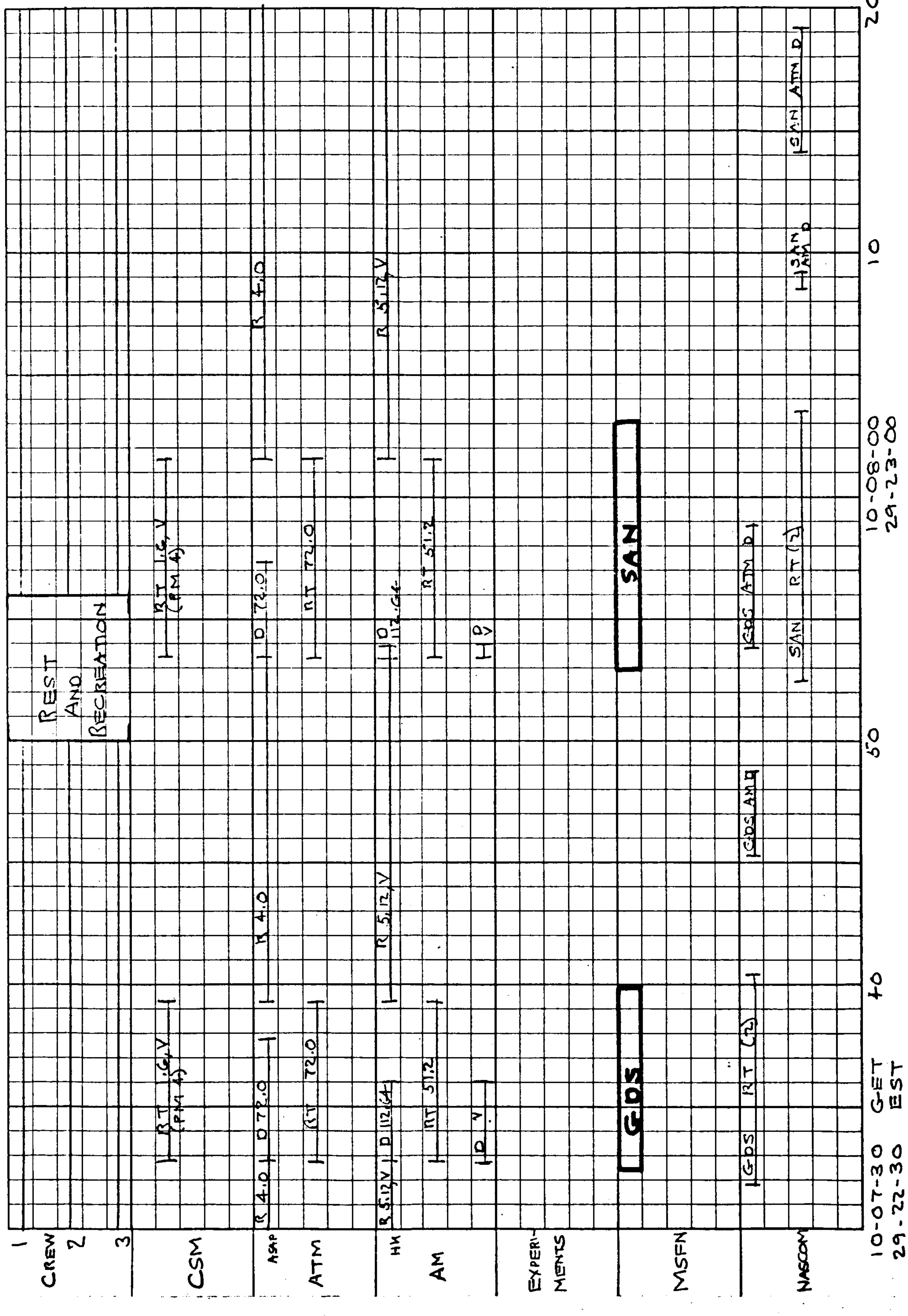


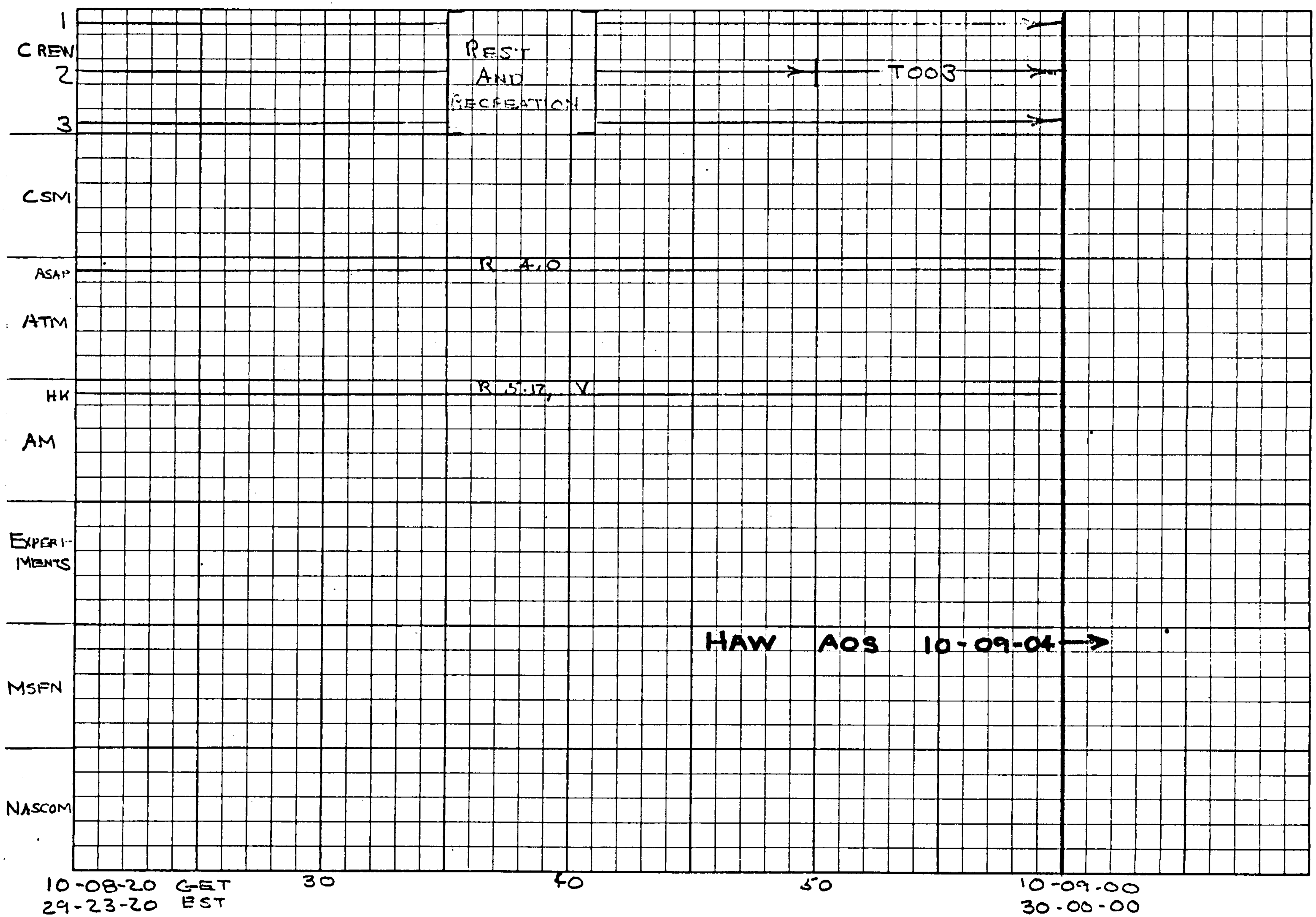
CREW
1 M 093 (SUBJECT)
2 M 093 (OBSERVER)
3 HOUSEKEEPING
UNSCHEDULED
CSM
RT 1.6, V
(PM 4)
ASAP
R 4.0
D 72.0
ATM
RT 72.0
HK
R 5.12, V
P 1.2, 64
AM
RT 51.2
EXPERI-MENTS
R 5.12 (M093), V
R 5.12 (M018), V
MSFN
GDS
BDA
TEX
MIL
NASCOM
GDS RT (2)
GDS AM D
GDS ATM D
GWM ATM D
TEX RT (2)
BDA RT (2)
MIL RT (2)
10-04-10 GET
29-19-10 EST
20
30
40
50
10-05-00
29-20-00


CREW
1
2
3
UNSCHEDULED
UNSCHEDULED
HOUSEKEEPING
DINNER
M071
M073
M074
CSM
RT 1.6 V
(PM 4)
RT 1.6 V
(PM 4)
ASAP
R 4.0
ATM
RT 72.0
RT 72.0
HK
R 5.12, V
R 5.12, V
R 5.12, V
AM
RT 5.12
RT 5.12
10 V
EXPERI-
MENTS
MSFN
CRO
GWM
NASCOM
CRO RT (2)
CRO
AM
GWN RT (2)
GWM
AM
10-05-00 GET
29-20-00 EST
10
20
30
40
50


CREW
1
2
3
CSM
ASAF
ATM
AM
EXPERI-MENTS
MSFN
NASCOM
REST AND RECREATION
DINNER
M071
M073
M074
M012
GDS
TEX
MIL
SAN
10-05-50 GET
29-20-50 EST
10-06-00
29-21-00
10
20
30
40


CREW
1
2
3
CSM
ASAP
ATM
HK
AM
EXPERI-
MENTS
MSFN
NASCOM
REST
AND
RECREATION
R 4.0
R 5.12, V
GDS M093 VCG #2
GDS M093 VCG #3
10-06-40
29-21-40
GET
EST
50
10-07-00
29-22-00
10
20
30


CREW
1
2
3
CSM
ASAP
ATM
HK
AM
EXPERI-
MENTS
MSFN
NASCOM
10-07-30
29-22-30
GET
EST
40
50
10-08-00
29-23-00
10
20
RT .G,V
(PM 4)
R 4.0
D 72.0
RT 72.0
R 5.12,V
D 112,G4
RT 51.2
D V
GDS
GDS
RT (2)
REST
AND
RECREATION
RT 1.G,V
(PM 4)
R 4.0
D 72.0
RT 72.0
R 5.12,V
D
112,G4
RT 51.2
D
V
SAN
GDS ATM D
SAN
RT (2)
GDS AM D
SAN ATM D
SAN
AM D


1
CREW
2
3
CSM
ASAP
ATM
HK
AM
EXPERI-
MENTS
MSFN
NASCOM
REST
AND
RECREATION
T003
R 4.0
R 5.17, V
HAW AOS 10-09-04
10-08-20 GET
29-23-20 EST
30
40
50
10-09-00
30-00-00

APPENDIX C

DATA LOADS FOR MSFN STATIONS

This appendix totals the data received by each MSFN station by pass time and vehicle module. Two tabulations are given for each station. The upper tabulation is of all received data, the lower tabulation is of unique data only. Summary tables are included as C-13 (total data) and C-14 (unique data).

Biomedical data, both operational and experimental, has been excluded from the totals. Due to the low redundancy factor of such data it was assumed not to be subject to data redundancy removal. All biomed data was assumed to be transmitted post-pass, one VCG component at a time (plus related lower rate data where appropriate). The total biomed data load excluded from these totals is 3.8×10^7, or about 1% of the unique data total.

The data loads imposed on the three 85' stations are not necessarily typical, due to the fact that they were also used for lunar support. MAD and GDS on this day happened to have Skylab contacts largely or entirely separated in time from lunar visibility. The converse was true of HSK. At different times of the lunar month, different overlap patterns will result.

The meanings of the entries on Tables C-1 through C-14 are as follows:

AOS - The time of site acquisition in days: hours: minutes: seconds at a 2° elevation angle above the horizon of a smooth earth.

Length - Pass length in minutes from AOS to LOS (loss of signal) below 2° elevation angle.

CSM 1.6 RT - Minutes of CSM 1.6 kbps real-time data transmitted during this pass. The CSM, ATM, and AM real-time transmission duration is always one minute less than the pass duration.

CSM 51.2 RT - Minutes of CSM 51.2 kbps real-time data transmitted during this pass.

CSM 51.2 D - Minutes of CSM data recorded at a 1.6 kbps rate dumped at a 51.2 kbps rate during this pass. (Occurs only once, to MIL.)

ATM 72.0 RT - Minutes of ATM 72.0 kbps real-time data transmitted during this pass. Transmitted on every pass.

ATM 72.0 D - Minutes of ATM data recorded at a 4.0 kbps rate dumped at a 72.0 kbps rate during this pass. Always 5.0 minutes long. Where another station code appears in this column, that station has overlapping coverage, and the data was assumed dumped to it.

AM 51.2 RT - Minutes of AM 51.2 kbps real-time data transmitted during this pass.

AM 112.64 D - Minutes of AM data recorded at a 5.12 kbps rate dumped at a 112.64 kbps rate during this pass. Duration is 1/22 the recording time. Same comment as above for overlapping coverage.

AM 126.72 D - Minutes of AM data recorded at a 5.76 kbps rate dumped at a 126.72 kbps rate during this pass. Same comments as above.

Bits of data - Total data collected by the station for all passes from all sources.

Overlap Removed Section - Same as above except:

(1) Stations with a pass 100% overlapped by other stations collect no unique data,

(2) All data transmitted to a station with overlapping coverage and earlier acquisition was eliminated from the load for the station under consideration, except for a one-half minute guard interval.

Table C-1

Data Load for Merrit Island (MIL)

AOS	Length	Minutes of Data: CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:18:36:22.1	6.6	5.6			5.6	5.0	5.6	1.4		
20:11:30.6	10.1	9.1			9.1	(TEX)	9.1	(TEX)	2.8	
21 51 00.1	6.8	5.8			5.8	(TEX)	5.8	(TEX)		
10 02 47 43.0	7.9	6.9		3.8	6.9	5.0	6.9	0.2		
04 24 13.8	10.2	9.2			9.2	(GDS)	9.2	(GDS)		
06 04 07.6	3.9	2.9			2.9	(GDS)	2.9	(GDS)		
Total (Min)	45.5	39.5		3.8	39.5	10.0	39.5	1.6	2.8	
(Bits $X10^6$)		4		12	171	43	121	10	21	382

Overlap Removed

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:18:36:22.1	6.6	5.6			5.6	1.8	5.6	1.4		
20 11:30.6			Overlapped by TEX and BDA						2.8	
21 51 00.1	2.6	2.1			2.1	--	2.1	--		
10:07 47 43.0	7.9	6.9		3.8	6.9	0.3	6.9	0.2		
04 24 13.8	9.3	8.8			8.8	--	8.8			
06 04 07.6			Overlapped by GDS and TEX							
Total (Min)	26.4	23.4		3.8	23.4	2.1	23.4	1.6	2.8	
(Bits $X10^6$)		2		12	101	9	72	10	21	227

Table C-2

Data Load for Bermuda (BDA)

Minutes of Data

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:18:38:00.5	9.6	8.6			8.6	(MIL)	8.6	(MIL)		
20 15 26.7	9.4	8.4			8.4	(TEX)	8.4	(TEX)		
21 55 41.4	5.6	4.6			4.6	(TEX)	4.6	(TEX)		
23 35 38.1	3.8	2.8			2.8	--	2.8	0.3		
10 1 12 17.8	8.0		7.0		7.0	5.0	7.0	0.2		
2 48 58.8	10.2	9.2			9.2	(MIL)	9.2	(MIL)		
4 27 33.0	6.8	5.8			5.8	(GDS)	5.8	(GDS)		
Totals (Min)	53.4	39.4	7.0		46.4	5.0	46.4	0.5		
(Bits $x10^6$)		4	21		200	22	142	3		392
Overlap Removed										
9:18:38:00.5	5.2	4.7			4.7		4.7			
20 15 26.7	7.2	6.7			6.7		6.6			
21 55 41.4	4.0	3.5			3.5		3.5			
23 35 38.1	3.8	2.8			2.8		2.8	0.3		
10 01 12 17.8	8.0		7.0		7.0	0.3	7.0	0.2		
2 48 58.8	4.0	3.5			3.5		3.5			
4 27 33.0	Overlapped by TEX and MIL									
Totals (Min)	32.2	21.2	7.0		28.2	0.3	28.2	0.5		
(Bits $X10^6$)		2	21		122	1	87	3		236

Table C-3

Data Load for Canary (CYI)

Minutes of Data

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:13:57:48.5	2.3		Too short							
15 30 40.6	10.0	9.0			9.0	5.0	9.0	0.6		
17 09 21.3	7.9	6.9			6.9	5.0	6.9	0.7		
22 07 47.5	6.0	5.0			5.0	(MAD)	5.0	(MAD)		
23 43 42.1	10.1	9.1			9.1	5.0	9.1	0.3		
10 01 21 5.0	7.6		6.6		6.6	5.0	6.6	0.2		
Totals (Min)	41.6	30.0	6.6		36.6	20.0	36.6	1.8		
(Bits $X10^6$)		3	20		158	86	112	12		391

Overlap Removed

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:13:57:48.5			Too short							
15 30 40.6	10.0	9.0			9.0	0.8	9.0	0.6		
17 09 21.3	7.9	6.9			6.9	0.9	6.9	0.7		
22 07 47.5			Overlapped by MAD							
23 43 42.1	10.1	9.1			9.1	0.9	9.1	0.3		
10 01 21 55.0	7.6		6.6		6.6	0.2	6.6	0.2		
Totals (Min)	35.6	25.0	6.6		31.6	2.8	31.6	1.8		
(Bits $X10^6$)		2	20		136	12	97	12		279

Table C-4

Data Load for Madrid (MAD)

Minutes of Data

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:14:01:30.4	3.7	2.7			2.7	--	2.7	0.3		
15 34 57.9	9.9	8.9			8.9	(CYI)	8.9	(CYI)		
17 12 22.6	9.8	8.8			8.8	(CYI)	8.8	(CYI)		
18 50 54.9	8.9	7.9			7.9	5.0	7.9	0.2		
20 28 50.6	9.4	8.4			8.4	5.0	8.4	0.3		
22 06 07.0	10.2	9.2			9.2	5.0	9.2	0.3		
23 44 12.2	7.7	6.7			6.7	(CYI)	6.7	(CYI)		
Totals (Min)	59.6	52.6			52.6	15.0	52.6	1.1		
(Bits $X10^6$)		5			227	65	161	7		465

Overlap Removed

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:14:01:30.4	3.7	2.7			2.7	--	2.7	0.3		
15 34 57.9	4.6	4.1			4.1	--	4.1			
17 12 22.6	5.4	4.9			4.9	--	4.9			
18 50 54.9	8.9	7.9			7.9	0.3	7.9	0.2		
20 28 50.6	9.4	8.4			8.4	0.4	8.4	0.3		
22 06 07.0	10.2	9.2			9.2	0.5	9.2	0.3		
23 44 12.2	--	--			--	--	--	--		
Totals (Min)	42.2	37.2			37.2	1.2	37.2	1.1		
(Bits $X10^6$)		4			161	5	114	7		291

Table C-5

Data Load for Ascension (ACN)

Minutes of Data

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:12:10:52.3	6.4	5.4			5.4	5.0	5.4	0.6		
13 46 25.1	9.8	8.8			8.8	5.0	8.8	0.3		
10 01 28 56.4	9.3		8.3		8.3	(CYI)	8.3	(CYI)		
3 06 35.1	8.4	7.4	___		7.4	5.0	7.4	0.4		
Totals (Min)	33.9	21.6	8.3		29.9	15.0	29.9	1.3		
(Bits $X10^6$)		2	25		129	65	92	9		322

Overlap Removed

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:12:10:52.3	6.4	5.4			5.4	2.5	5.4	0.6		
13 46 25.1	9.8	8.8			8.8	0.5	8.8	0.3		
10 01 28 56.4	9.3		8.3		8.3	--	8.3	--		
3 06 35.1	8.4	7.4	___		7.4	0.6	7.4	0.4		
Totals (Min)	34.3	21.6	8.3		29.9	3.6	29.9	1.3		
(Bits $X10^6$)		2	25		129	16	92	9		273

Table C-6

Data Load for Carnarvon (CRO)

Minutes of Data

ASO	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.74 D	Bits of Data ($X10^6$)
9:17:48:19.2	8.6		7.6		7.6	5.0	7.6	1.4		
19 24 50.0	9.8	8.8			8.8	5.0	8.8	2.6[3]		
21 06 41.3	2.4		Too short							
10 02 02 42.9	7.0	6.0			6.0	5.0	6.0	--[1]		
3 38 48.5	10.1	9.1			9.1	5.0	9.1	2.0[2]		
5 18 49.6	3.7	2.7			2.7	--	2.7	2.0		
Total (Min)	39.2	34.2			34.2	20.0	34.2	6.6		
(Bits $X10^6$)		3			148	86	105	45		387
			Overlap Removed							
9:17:48:19.2	8.6		7.6		7.6	1.8	7.6	1.4		
19 24 50.0	9.8	8.8			8.8	1.5	8.8	2.6[3]		
21 06 41.3	2.4	--			--	--	--	--		
10 02 02 42.9	7.0	6.0			6.0	1.5	6.0	--[1]		
3 38 48.5	10.1	9.1			9.1	1.5	9.1	2.0[2]		
5 18 49.6	3.7	2.7			2.7	--	2.7	2.0		
Total (Min)	39.2	34.2			34.2	6.3	34.2	6.6		
(Bits $X10^6$)		3			148	27	105	45		328

[1] T025 in operation. Dump later

[2] 1.2 min of housekeeping, 0.8 min of M131 data

[3] 1.4 min of operational biomed not included in total

Table C-7

Data Load for Honeysuckle (HSK)

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
		Minutes of Data								
9:16:18:50.9	9.0	8.0			8.0	5.0	8.0	1.6		
17 55 24.1	10.1		9.1		9.1	(CRO)	9.1	(CRO)		
19 34 31.0	7.9			ALSEP	Support					
21 13 48.9	6.7			ALSEP	Support					
22 51 16.8	8.8			ALSEP	Support					
10 00 28 17.8	10.1			ALSEP	Support					
2 07 01.7	6.2			ALSEP	Support					
Totals (Min)	19.1	8.0	9.1		17.1	5.0	17.1	1.6		
(Bits $X10^6$)		1	28		74	22	52	11		188
				Overlap Removed						
9:16:18:50.9	9.0	8.0			8.0	2.0	8.0	1.6		
17 55 24.1	9.0		9.1		9.1	--	9.1	--		
19 34 31.0				ALSEP	Support					
21 13 48.9				ALSEP	Support					
22 51 16.8				ALSEP	Support					
10 00 28 17.8				ALSEP	Support					
2 07 01.7				ALSEP	Support					
Totals (Min)	19.1	8.0	9.1		17.1	2.0	17.1	1.6		
(Bits $X10^6$)		1	28		74	9	52	11		175

Table C-8

Data Load for Guam (GWM)

Minutes of Data

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:12:55:40.8	4.2	3.2			3.2	--	3.2	1.8		
14 30 14.4	10.2	9.2			9.2	5.0	9.2	1.2		
16 11 13.2	2.2		Too Short							
10 02 18 37.6	2.7		Too Short							
3 51 56.4	10.0	9.0			9.0	5.0	9.0	0.2		
5 32 48.6	3.4	2.4			2.4	--	2.4	0.5		
Totals (Min)	27.8	23.8			23.8	10.0	23.8	3.7		
(Bits $X10^6$)		2			103	43	73	25		246

Overlap Removed

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:12:55:40.8	4.2	3.2			3.2	--	3.2	1.8		
14 30 14.4	10.2	9.2			9.2	2.1	9.2	1.2		
16 11 13.2	2.2		Too Short							
10 02 18 37.6	2.7		Too Short							
3 51 56.4	10.0	9.0			9.0	0.4	9.0	0.2		
5 32 48.6	3.4	2.4			2.4	--	2.4	0.5		
Total (Min)	27.8	23.8			23.8	2.5	23.8	3.7		
(Bits $X10^6$)		2			103	11	73	25		214

Table C-9

Data Load for Hawaii (HAW)

Minutes of Data

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data (X10^6)
9:09:46:19.0	9.8	8.8			8.8	5.0	8.8	2.7		
11 24 11.6	8.1		7.1		7.1	5.0	7.1	2.9		
23 14 24.8	4.7	3.7			3.7	--	3.7	2.7		
10 00 48 38.6	10.0	--	9.0		9.0	5.0	9.0	4.0[2]		
2 28 36.7	5.5	4.5			4.5	--	4.5	--[1]		
Totals (Min)	38.1	17.0	16.1		33.1	15.0	33.1	10.9		
(Bits X10^6)		2	49		143	65	102	74		435
Overlap Removed										
9:09:46:19.0	9.8	8.8			8.8	3.5	8.8	2.7		
11 24 11.6	8.1		7.1		7.1	3.7	7.1	2.9		
23 14 24.8	4.7	3.7			3.7	--	3.7	2.7		
10 00 48 38.6	10.0	--	9.0		9.0	3.3	9.0	4.0[2]		
2 28 36.7	5.5	4.5			4.5	--	4.5	--[1]		
Totals (Min)	38.1	17.0	16.1		33.1	10.5	33.1	10.9		
(Bits X10^6)		2	49		143	45	102	74		415

[1] Experiment T025 in operation. Dump later.

[2] Includes 1.4 min biomed not included in total.

Table C-10

Data Load for Goldstone (GDS)

Minutes of Data

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:21:45:02.2	8.3			ALSEP	Support					
23 21 09.0	10.0	9.0			9.0	5.0	9.0	1.6[3]		
10 01 00 05.8	8.0		7.0		7.0	5.0	7.0	0.2		
2 39 34.2	6.4	5.4			5.4	5.0	5.4	2.9[1]		
4 17 09.9	8.5	7.5			7.5	5.0	7.5	0.7		
5 54 05.9	10.2		9.2		9.2	5.0	9.2	2.9[2]		
7 32 19.0	7.5	6.5			6.5	5.0	6.5	3.1		
Totals (Min)	50.6	28.4	16.2		44.6	30.0	44.6	8.0		
(Bits $X10^6$)		3	50		193	130	137	54		567

Overlap Removed

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:21:45:02.2	8.3			ALSEP	Support					
23 21 09.0	10.0	9.0			9.0	3.8	9.0	1.6[3]		
10 01 00 05.8	8.0		7.0		7.0	0.3	7.0	0.2		
2 39 34.2	6.4	5.4			5.4	0.7	5.4	2.9[1]		
4 17 09.9	8.5	7.5			7.5	1.0	7.5	0.7		
5 54 05.9	10.2		9.2		9.2	4.6	9.2	2.9[2]		
7 32 19.0	7.5	6.5			6.5	3.9	6.5	3.1		
Totals (Min)	50.6	28.4	16.2		44.6	14.3	44.6	8.0		
(Bits $X10^6$)		3	50		193	62	137	54		499

[1] Dump of T025 housekeeping data

[2] 2 1.0 min period of biomed (M093) not included in total

[3] includes 1.4 min of biomed not included in total

Table C-11

Data Load for Texas (TEX)

Minutes of Data

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:20:09:15.5	8.9	7.9			7.9	5.0	7.9	1.7		
21 46 06.3	9.5	8.5			8.5	5.0	8.5	3.1		
23 27 22.3	3.5	2.5			2.5	(GDS)	2.5	(GDS)		
10 04 21 59.6	9.0	8.0			8.0	(GDS)	8.0	(GDS)		
5 58 56.5	9.8		8.8		8.8	(GDS)	8.8	(GDS)		
Totals (Min)	40.7	26.9	8.8		35.7	10.0	35.7	4.8		
(Bits $X10^6$)		3	38		154	43	110	32		380
Overlap Removed										
9:20:09:15.5	8.9	7.9			7.9	2.1	7.9	1.7		
21 46 06.3	9.5	8.5			8.5	3.9	8.5	3.1		
23 27 22.3	Overlapped by GDS									
10 04 21 59.6	Overlapped by GDS, MIL, and BDA									
5 58 56.5	5.0		4.5		4.5	--	4.5	--		
Totals (Min)	23.4	16.4	4.5		20.9	6.0	20.9	4.8		
(Bits $X10^6$)		2	19		90	26	64	32		233

Table C-12
Data Load for Santiago (SAN)
Minutes of Data

AOS	Length	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
9:10:15:04.0	6.8	5.8			5.8	5.0	5.8	0.9		
11 55 11.6	4.4	3.4			3.4	--	3.4	1.1		
13 32 23.2	7.6	6.6			6.6	5.0	6.6	1.5		
15 09 04.9	10.0	9.0			9.0	5.0	9.0	1.4		
16 47 13.4	7.6	6.6			6.6	5.0	6.6	1.0		
10 06 16 59.9	8.0	7.0			7.0	5.0	7.0	0.4		
7 52 55.9	10.1	9.1			9.1	5.0	9.1	0.7		
Totals (Min)	54.5	47.5			47.5	30.0	47.5	7.0		
(Bits $X10^6$)		5			205	130	146	47		533
Overlap Removed										
9:10:15:04.0	6.8	5.8			5.8	1.3	5.8	0.9		
11 55 11.6	4.4	3.4			3.4	--	3.4	1.1		
13 32 23.2	7.6	6.6			6.6	2.0	6.6	1.5		
15 09 04.9	10.0	9.0			9.0	1.8	9.0	1.4		
16 47 13.4	7.6	6.6			6.6	1.3	6.6	1.0		
10 06 16 59.9	8.0	7.0			7.0	0.6	7.0	0.4		
7 52 55.9	10.1	9.1			9.1	0.9	9.1	0.7		
Totals (Min)	54.5	47.5			47.5	7.9	47.5	7.0		
(Bits $X10^6$)		5			205	34	146	47		437

Table C-13

Total Data Load

Minutes of Data

Site	Passes Supported >3 min	>6 min	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
MIL	6	5	39.5		3.8	39.5	10.0	39.5	3.6	2.4	382
BDA	7	5	39.4	7.0		46.4	5.0	46.4	0.5		392
CYI	5	5	30.0	6.6		36.6	20.0	36.6	1.8		391
MAD	7	6	52.6			52.6	15.0	52.6	1.1		465
ACN	4	4	21.6	8.3		29.9	15.0	29.9	1.3		322
CRO	5	4	34.2			34.2	20.0	34.2	6.6		387
HSK	2	2	8.0	9.1		17.1	5.0	17.1	1.6		188
GWM	4	2	23.8			23.8	10.0	23.8	3.7		246
HAW	5	3	17.0	16.1		33.1	15.0	33.1	10.9		435
GDS	6	6	28.4	16.2		44.6	30.0	44.6	8.0		567
TEX	5	4	26.9	8.8		35.7	10.0	35.7	4.8		380
SAN	7	6	47.5			47.5	30.0	47.5	7.0		533
Totals	63	52	368.9	72.1	3.8	441.0	185.0	441.0	50.9	2.4	4688
											74 per pass
											391 per sta.

Table C-14

Total Data Load-Overlap Removed

Minutes of Data

Site	Passes Supported >3 min	Passes Supported >6 min	CSM 1.6 RT	CSM 51.2 RT	CSM 51.2 D	ATM 72.0 RT	ATM 72.0 D	AM 51.2 RT	AM 112.64 D	AM 126.72 D	Bits of Data ($X10^6$)
MIL	6	5	23.4		3.8	23.4	2.1	23.4	3.6	2.4	227
BDA	7	5	21.2	7.0		28.2	0.3	28.2	0.5		236
CYI	5	5	25.0	6.6		31.6	2.8	31.6	1.8		279
MAD	7	6	37.2			37.2	1.2	37.2	1.1		291
ACN	4	4	21.6	8.3		29.9	3.6	29.9	1.3		273
CRO	5	4	34.2			34.2	6.3	34.2	6.6		328
HSK	2	2	8.0	9.1		17.1	2.0	17.1	1.6		175
GWM	4	2	23.8			23.8	2.5	23.8	3.7		214
HAW	5	3	17.0	16.1		33.1	10.5	33.1	10.9		415
GDS	6	6	28.4	16.2		44.6	14.3	44.6	8.0		499
TEX	5	4	16.4	4.5		20.9	6.0	20.9	4.8		233
SAN	7	6	47.5			47.5	7.9	47.5	7.0		437
Totals	63	52	303.7	67.8	3.8	371.5	59.5	371.5	50.9	2.4	3607

57 per pass

301 per sta.